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EDEXCEL INTERNATIONAL A LEVEL MATHS: QUESTIONS BY TOPIC

Continuous Random Variables (S2.2)

International A Level Mathematics · S2: Statistics 2 (WST02)

42 questions · 479 marks · Mark schemes included

Past papers October 2020 - June 2025 · 2 sub-topics

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HOW TO USE THIS BOOKLET

Questions are grouped by sub-topic and run from the lowest to the highest mark tariff, then oldest paper first.

Click any row below to jump straight to that sub-topic or question.

On every question page, click ANSWER in the top-right corner to jump to its mark scheme; < QUESTION brings you back.

A gold bar in the left margin marks exactly where the question sits on the original page.

Diagrams, graphs, grids and tables are printed exactly as they appear in the original papers.

Each question is filed under its main topic; longer questions may also test skills from other topics.

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2. Q2	IAL S2 (WST02) January 2022	8	8
3. Q2	IAL S2 (WST02) October 2023	8	12
4. Q7	IAL S2 (WST02) January 2024	8	16
5. Q5	IAL S2 (WST02) October 2022	9	21
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S2.2b THE CONTINUOUS UNIFORM DISTRIBUTION		11 Qs · 120 marks	130
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35. Q3	IAL S2 (WST02) June 2022	10	140
36. Q5	IAL S2 (WST02) January 2024	10	144
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QUESTIONS

42 questions · 479 marks · 2 sub-topics

SUB-TOPIC S2.2a

PROBABILITY DENSITY & CUMULATIVE DISTRIBUTION FUNCTIONS

Sub-topic S2.2a · 31 questions · 359 marks · lowest tariff first



Question 1 continued

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Question 1 continued

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Question 1 continued

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Q1

(Total 8 marks)



Question 2 continued

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Question 2 continued

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Question 2 continued

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(Total 8 marks)

Q2



Question 2 continued





Question 2 continued

(Total for Question 2 is 8 marks)



Question 7 continued



Question 7 continued



TOTAL FOR PAPER IS 75 MARKS



Question 5 continued



Question 5 continued

Question 5 continued

(Total for Question 5 is 9 marks)



Question 3 continued



Question 3 continued

Question 3 continued

(Total for Question 3 is 9 marks)



Question 2 continued



Question 2 continued

Question 2 continued

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(Total for Question 2 is 9 marks)



Question 5 continued



Question 5 continued



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(Total for Question 5 is 9 marks)



Question 2 continued

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Q2



Question 4 continued

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(Total 10 marks)

Q4



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Question 3 continued

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(Total 10 marks)

Q3



Question 4 continued



Question 4 continued

Question 4 continued

(Total for Question 4 is 10 marks)



Question 4 continued



Question 4 continued



Question 4 continued

(Total for Question 4 is 10 marks)



Question 7 continued

Question 7 continued

(Total for Question 7 is 10 marks)

TOTAL FOR PAPER: 75 MARKS

5. A game uses two turntables, one red and one yellow. Each turntable has a point marked on the circumference that is lined up with an arrow at the start of the game. Jim spins both turntables and measures the distance, in metres, each point is from the arrow, around the circumference in an anticlockwise direction when the turntables stop spinning.

The continuous random variable Y represents the distance, in metres, the point is from the arrow for the yellow turntable. The cumulative distribution function of Y is given by $F(y)$ where

$$F(y) = \begin{cases} 0 & y < 0 \\ 1 - (\alpha + \beta y^2) & 0 \leq y \leq 5 \\ 1 & y > 5 \end{cases}$$

- (a) Explain why (i) $\alpha = 1$

(ii) $\beta = -\frac{1}{25}$ (2)

- (b) Find the probability density function of Y

(2)

The continuous random variable R represents the distance, in metres, the point is from the arrow for the red turntable. The distribution of R is modelled by a continuous uniform distribution over the interval $[d, 3d]$

Given that $P\left(R > \frac{11}{5}\right) = P\left(Y > \frac{5}{3}\right)$

- (c) find the value of d

(3)

In the game each turntable is spun 3 times. The distance between the point and the arrow is determined for each spin. To win a prize, at least 5 of the distances the point is from the arrow when a turntable is spun must be less than $\frac{11}{5}$ m

Jo plays the game once.

- (d) Calculate the probability of Jo winning a prize.

(4)

Question 5 continued



Question 5 continued



Question 5 continued

(Total for Question 5 is 11 marks)



Question 2 continued



Question 2 continued

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Question 2 continued

Lined area for writing the answer to Question 2.

(Total for Question 2 is 11 marks)



Question 1 continued

Question 1 continued



Question 1 continued

(Total for Question 1 is 11 marks)



Question 5 continued

Lined area for writing the answer to Question 5 continued.



Question 5 continued



Question 5 continued

(Total for Question 5 is 11 marks)

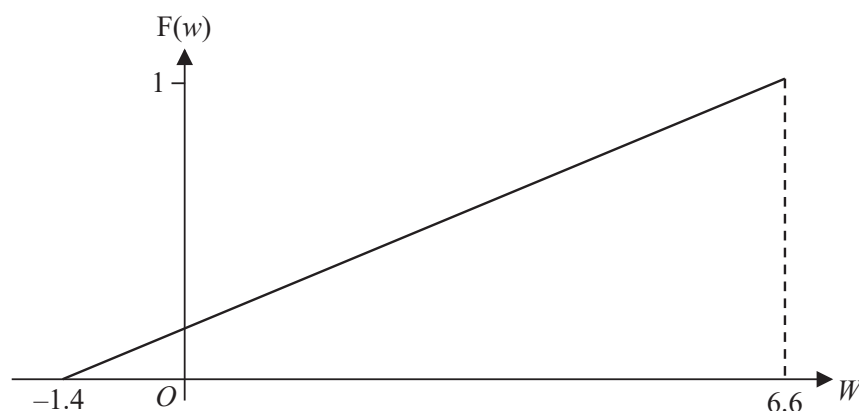


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2. In the summer Kylie catches a local steam train to work each day. The published arrival time for the train is 10 am.

The random variable W is the train's actual arrival time minus the published arrival time, in minutes. When the value of W is positive, the train is late.

The cumulative distribution function $F(w)$ is shown in the sketch below.



- (a) Specify fully the probability density function $f(w)$ of W . (2)
- (b) Write down the value of $E(W)$. (1)
- (c) Calculate α such that $P(\alpha \leq W \leq 1.6) = 0.35$. (2)

A day is selected at random.

- (d) Calculate the probability that on this day the train arrives between 1.2 minutes late and 2.4 minutes late. (2)

Given that on this day the train was between 1.2 minutes late and 2.4 minutes late,

- (e) calculate the probability that it was more than 2 minutes late. (2)

A random sample of 40 days is taken.

- (f) Calculate the probability that for at least 10 of these days the train is between 1.2 minutes late and 2.4 minutes late. (3)

Question 2 continued

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Question 2 continued

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(Total 12 marks)

Q2



6. The continuous random variable Y has cumulative distribution function given by

$$F(y) = \begin{cases} 0 & y < 0 \\ \frac{1}{21}y^2 & 0 \leq y \leq k \\ \frac{2}{15}\left(6y - \frac{y^2}{2}\right) - \frac{7}{5} & k < y \leq 6 \\ 1 & y > 6 \end{cases}$$

- (a) Find $P\left(Y < \frac{1}{4}k | Y < k\right)$ (2)
- (b) Find the value of k (4)
- (c) Use algebraic calculus to find $E(Y)$ (6)

Question 6 continued



Question 6 continued



Question 6 continued

(Total for Question 6 is 12 marks)



Question 4 continued



Question 4 continued

Question 4 continued

(Total for Question 4 is 12 marks)



Question 5 continued

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Question 5 continued

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(Total 13 marks)

Q5



Question 6 continued

Question 6 continued



Question 6 continued

(Total for Question 6 is 13 marks)





Question 5 continued

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Question 5 continued

(Total for Question 5 is 14 marks)



Question 3 continued

Question 3 continued

Question 3 continued

(Total for Question 3 is 15 marks)



Question 4 continued

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Question 4 continued

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Question 4 continued

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(Total 15 marks)

Q4



Question 2 continued



Question 2 continued



Question 2 continued

(Total for Question 2 is 15 marks)



7. The continuous random variable X has probability density function given by

$$f(x) = \begin{cases} ax & 0 \leq x \leq 4 \\ bx + c & 4 < x \leq 8 \\ 0 & \text{otherwise} \end{cases}$$

where a , b and c are constants.

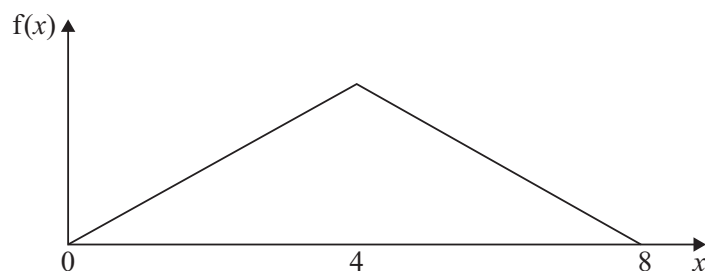


Figure 1

Figure 1 shows the graph of the probability density function $f(x)$

The graph consists of two straight line segments of equal length joined at the point where $x = 4$

(a) Show that $a = \frac{1}{16}$ (1)

(b) Hence find

(i) the value of b

(ii) the value of c (3)

(c) Using algebraic integration, show that $\text{Var}(X) = \frac{8}{3}$ (6)

(d) Find, to 2 decimal places, the lower quartile and the upper quartile of X (3)

A statistician claims that

$$P(-\sigma < X - \mu < \sigma) > 0.5$$

where μ and σ are the mean and standard deviation of X

(e) Show that the statistician's claim is correct. (2)

Question 7 continued





Question 7 continued



6 In this question solutions relying entirely on calculator technology are not acceptable.

The continuous random variable X has the following probability density function

$$f(x) = \begin{cases} a + bx & -1 \leq x \leq 3 \\ 0 & \text{otherwise} \end{cases}$$

where a and b are constants.

(a) Show that $4a + 4b = 1$

(3)

Given that $E(X^2) = \frac{17}{5}$

(b) (i) find an equation in terms of a only

(5)

(ii) hence show that $b = 0.1$

(2)

(c) Sketch the probability density function $f(x)$ of X

(2)

(d) Find the value of k for which $P(X \geq k) = 0.8$

(4)



Question 6 continued

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Question 6 continued

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TOTAL FOR PAPER IS 75 MARKS



Question 6 continued

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Question 6 continued

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Question 6 continued

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Question 6 continued

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Q6

(Total 17 marks)

END

TOTAL FOR PAPER: 75 MARKS

Question 6 continued



Question 6 continued

Question 6 continued



Question 6 continued

(Total for Question 6 is 18 marks)

TOTAL FOR PAPER IS 75 MARKS



SUB-TOPIC S2.2b

THE CONTINUOUS UNIFORM DISTRIBUTION

Sub-topic S2.2b · 11 questions · 120 marks · lowest tariff first



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7 The sides of a square are each of length L cm and its area is A cm²

Given that A is uniformly distributed on the interval $[10, 30]$

(a) find $P(L \geq 4.5)$

(2)

(b) find $\text{Var}(L)$

(6)



Question 7 continued

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Question 7 continued

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Q7

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(Total 8 marks)

TOTAL FOR PAPER: 75 MARKS

END



3. Every morning Navtej travels from home to work. Navtej leaves home at a random time between 08:00 and 08:15

- It always takes Navtej 3 minutes to walk to the bus stop
- Buses run every 15 minutes and Navtej catches the first bus that arrives
- Once Navtej has caught the bus it always takes a further 29 minutes for Navtej to reach work

Question 3 continued

Lined area for writing the answer to Question 3.

(Total for Question 3 is 9 marks)

Question 4 continued



Question 4 continued



Question 4 continued

Lined area for writing the answer to Question 4.

(Total for Question 4 is 9 marks)





Question 3 continued

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Question 3 continued

Lined area for writing the answer to Question 3.

(Total for Question 3 is 10 marks)



Question 5 continued





(Total for Question 3 is 16 marks)



Question 6 continued

Lined area for writing the answer to Question 6.

(Total for Question 6 is 10 marks)



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2. (i) The continuous random variable X is uniformly distributed over the interval $[a, b]$

Given that $P(8 < X < 14) = \frac{1}{5}$ and $E(X) = 11$

- (a) write down $P(X > 14)$ (1)

- (b) find $P(6X > a + b)$
- (4)**

- (ii) Susie makes a strip of pasta 45 cm long. She then cuts the strip of pasta, at a randomly chosen point, into two pieces. The random variable S is the length of the shortest piece of pasta.

- (a) Write down the distribution of S (1)

- (b) Calculate the probability that the shortest piece of pasta is less than 12 cm long. (2)

Susie makes 20 strips of pasta, all 45 cm long, and separately cuts each strip of pasta, at a randomly chosen point, into two pieces.

- (c) Calculate the probability that exactly 6 of the pieces of pasta are less than 12 cm long. (3)



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Question 2 continued

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(Total 11 marks)

Q2

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Question 7 continued



Question 7 continued





TOTAL FOR PAPER: 75 MARKS

6. Akia selects at random a value from the continuous random variable W , which is uniformly distributed over the interval $[a, b]$

The probability that Akia selects a value greater than 17 is $\frac{1}{5}$

The probability that Akia selects a value less than k is $\frac{53}{60}$

- (a) Find the probability that Akia selects a value between 17 and k

(2)

It is known that $\text{Var}(W) = 75$

- (b) (i) Find the value of a and the value of b

(4)

- (ii) Find the value of k

(2)

- (c) Find $P(-5 < W < 5)$

(2)

- (d) Find $E(W^2)$

(2)

Question 6 continued

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Question 6 continued

Lined area for writing the answer to Question 6 continued.



Question 6 continued

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(Total for Question 6 is 12 marks)



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Question 5 continued

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Q5	
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Question 3 continued





(Total for Question 3 is 15 marks)

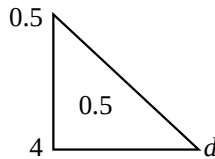
MARK SCHEMES

official mark schemes, in the same order as the questions



Question Number	Scheme	Marks
1 (a)	$\int_1^2 k \left(\frac{1}{2}x^3 - 3x^2 + ax + 1 \right) dx [= 1]$	M1
	$k \left[\frac{1}{8}x^4 - x^3 + \frac{1}{2}ax^2 + x \right]_1^2 [= 1]$	A1
	$k(2-8+2a+2) - k\left(\frac{1}{8}-1+\frac{1}{2}a+1\right) = 1$ or $k(2a-4) - k\left(\frac{1}{8}+\frac{1}{2}a\right) = 1$	dM1
	$-\frac{33}{8}k + \frac{3}{2}ka = 1 \therefore k(12a-33) = 8 *$	A1 *
		(4)
(b)	$\frac{df(x)}{dx} = k \left(\frac{3}{2}x^2 - 6x + a \right)$	M1
	$\frac{3}{2}x^2 - 6x + 5 = 0$ or $\frac{4}{9}x^2 - \frac{16}{9}x + \frac{40}{27} = 0$	dM1
	$x = \frac{6 \pm \sqrt{6^2 - 4 \times 1.5 \times 5}}{3}$	M1
	$x = 2 - \frac{\sqrt{6}}{3}$ oe or 1.183... awrt 1.18	A1
		(4)
Notes		Total 8
1(a)	M1	Attempting to integrate $f(x)$, (at least one term $x^n \rightarrow x^{n+1}$). Ignore limits. No Need to equate to 1
	A1	Fully correct integration. Allow not simplified. Ignore limits and accept any letters. Allow + C No Need to equate to 1
	dM1	Dep on 1 st M1. Subst in correct limits, subtracting results and equate to 1 Allow if they have + C the use of $F(2) = 1$ and $F(1) = 0$ to form 2 equations and solve to eliminate + C
	A1*	Answer is given. Correct solution only. At least one correct line of working required between $k(2a-4) - k\left(\frac{1}{8} + \frac{1}{2}a\right) = 1$ and the final given answer.
(b)	M1	Attempting to differentiate $f(x)$, (at least one term $x^n \rightarrow x^{n-1}$). Condone missing k or incorrect value for k
	dM1	Dependent on first Method mark being awarded. Putting their differential (or multiple of) = 0 May be implied by awrt 1.18 or awrt 2.82
	M1	Correct method for solving their 3 term quadratic equation. May be implied by awrt 1.18 or awrt 2.82 Minimum for method if final answer is incorrect is of the form $\frac{6 \pm \sqrt{6}}{3}$
	A1	Allow equivalent exact answer. awrt 1.18 Must eliminate the 2.816... or clearly indicate which of the 2 solutions is their answer

Question Number	Scheme		Marks
2 (a)	$f(x) = \begin{cases} \frac{1}{4k} & -k \leq x \leq 3k \\ 0 & \text{otherwise} \end{cases}$		M1 A1
			(2)
(b)	$E(X) = k$		B1
			(1)
(c)	$[\text{Var}(X)] = \frac{(3k - -k)^2}{12} = \frac{16k^2}{12} \quad \text{or} \quad \left[\frac{x^3}{3} f(x) \right]_{-k}^{3k} - (k)^2$		M1
	$= \frac{4k^2}{3} *$		A1* cso
			(2)
(d)	$E(X^2) = \text{Var}(X) + E(X)^2 = \frac{4k^2}{3} + (k)^2$		M1
	$= \frac{7k^2}{3}$		A1
	$E(3X^2) = 3E(X^2) = 3 \times \frac{7k^2}{3} = 7k^2$		A1
			(3)
	Notes		Total 8
2 (a)	M1	For the 1 st line of the pdf including the inequality, allow use of < instead of one/both $\leq$ signs	
	A1	Fully correct, allow use of < instead of one/both $\leq$ signs. Allow equivalent for the 0 otherwise.	
(b)	B1	Cao	
(c)	M1	Use of $\text{Var}(X) = \frac{(\beta - \alpha)^2}{12}$ or $\left[\frac{x^3}{3} f(x) \right]_{-k}^{3k} - (k)^2$	
	A1* cso	Answer is given. Correct solution only with no incorrect working.	
(d)	M1	Use of $E(X^2) = \text{Var}(X) + E(X)^2$ ft their $E(X)$ or $\left[\frac{x^3}{3} f(x) \right]_{-k}^{3k}$ this integration may be seen in part (c) or part (d)	
	A1	$\frac{7k^2}{3}$ (This must be seen in part (d)) May be implied by $7k^2$)	
	A1	Cao	

Question Number	Scheme		Marks
2 (a)	[Mode =] 4		B1
			(1)
(b)	$\left[a \int_0^4 x^3 dx = \frac{1}{2} \Rightarrow \right] a \left[\frac{x^4}{4} \right]_0^4 = \frac{1}{2}$		M1
	$64a = \frac{1}{2} \Rightarrow a = \frac{1}{128} *$		A1*
			(2)
(c)		$\frac{1}{2} \times \frac{1}{2} \times (d - 4) = \frac{1}{2} \quad \text{or} \quad \frac{1}{2} \times \frac{1}{2} \times (d - 4) + \int_0^4 ax^3 dx = 1$	M1
	$d = 6$		A1
			(2)
(d)	$b = \frac{-\frac{1}{2}}{'6'-4} \left[= -\frac{1}{4} \right]$	$4b + c = 0.5 \text{ oe}$	M1
	$0 = '-\frac{1}{4}' \times '6' + c \quad \text{or} \quad \frac{1}{2} = '-\frac{1}{4}' \times 4 + c$	$10b + 2c = 0.5 \text{ oe}$ or $'6'b + c = 0 \text{ oe}$	M1
	$b = -\frac{1}{4} \text{ and } c = \frac{3}{2}$		A1
			(3)
Notes			Total 8
(a)	B1	Cao	
(b)	M1	For integrating the 1 st line of the pdf and setting = 0.5 Ignore limits	
	A1*	Answer is given so a correct solution must be seen with no errors. There must be at least one line of correct working from the M mark to the final answer.	
		Mark parts c and d together	
(c)	M1	For setting the area of the triangle = 0.5	
	A1	Cao	
(d)	M1	A correct method for finding b ft their d value or $4b + c = 0.5 \text{ oe}$ (this may be seen any part of this question) Allow $4b + c = 64a$	
	M1	A correct method for finding c ft their b and d value or $10b + 2c = 0.5 \text{ oe}$ or $'d' \times b + c = 0 \text{ oe}$ (these may be seen any part of this question) Allow $db + c = 0$	
	A1	For both b and c correct NB $b = -0.25 \text{ oe}$ and $c = 1.5 \text{ oe}$ will score 3/3	

Question Number	Scheme			Marks
7(a)	$f(x) = [k](a + 3bx^2 - 4x^3)$			M1
	$[k](6bx - 12x^2) = 0$			M1
	$9b - 27 = 0 \Rightarrow b = 3$ or $6 \times 3 \times 1.5 - 12 \times 1.5^2 = 0 \Rightarrow \therefore b = 3^*$			A1*
				(3)
(b)	$a + 3 - 1 - 4 = 0$ oe $[\Rightarrow a = 2]$			B1*
				(1)
(c)	$k(2 \times 2 + 3 \times 2^3 - 2^4 - 4) = 1 \quad \left[\Rightarrow k = \frac{1}{8} \right]$			M1
	F(x) = 0.5	F(x) = 4	F(x) = 0	
	F(1.4) = 0.3988... F(1.5) = 0.5078...	F(1.4) = 3.1904... F(1.5) = 4.0625...	F(1.4) = -0.8(096...) F(1.5) = 0.06(25...)	M1A1
	0.399 < 0.5 < 0.508 therefore, the median lies between 1.4 and 1.5	3.1904 < 4 < 4.0625 therefore, the median lies between 1.4 and 1.5	-0.8(096) < 0 < 0.06(25) therefore, the median lies between 1.4 and 1.5	A1
	ALTERNATIVE M1A1A1 for F(x) = 0			
	$x_1 = 2.91... \quad x_2 = 1.49... \quad x_3 = -0.70... \text{ So } x = 1.49... \text{ as } 1 \leq x \leq 2$			M1 A1
	$1.4 < 1.49... < 1.5$ [therefore, the median lies between 1.4 and 1.5]			dA1
				(4)
Notes				Total 8
(a)	M1	for attempting to differentiate $x^n \rightarrow x^{n-1}$ Condone missing k (May be implied by 2 nd M1)		
	M1	for correctly differentiating twice and equating to zero. Condone missing k		
	A1*	substituting $x = 1.5$ leading to a correct linear equation in b leading to $b = 3$		
(b)	B1*	for correctly using $F(1) = 0$ to form an equation in a (May be seen in part (a)) and substitution of $b = 3$		
(c)	M1	for using $F(2) = 1$ to form a correct equation in terms of k only. May be seen in any part of the question		
	M1	For a calculation of $F(1.4)$ or $F(1.5)$ correct to 2 sf (If $F(x) = 0$ used then allow 1 sf or better) (Allow $F(1.4) = \text{awrt } 3.190k$ or $F(1.5) = \text{awrt } 4.063k$)		
	A1	For a calculation of $F(1.4)$ and $F(1.5)$ correct to 2 sf (If $F(x) = 0$ used then allow 1 sf or better)		
	dA1	Dependent on previous A1. For a correct comparison and conclusion. Allow comparisons in words e.g. For $F(X) = 0$ a comment about a change in sign implies a comparison with 0		
		ALTERNATIVE		
	M1	For solving the given equation. May be implied by 2.91... or 1.49... or -0.70...		
	A1	For $x = 1.49...$ identified as being in the range specified by the CDF. May be implied by rejecting the other solutions		
	dA1	Dependent on previous A1. For a correct comparison and conclusion		

Examples of other acceptable comparisons for 0.5

$F(1.4) < 0.5 < F(1.5)$, Median lies between the range

$F(1.4) < F(\text{median}) < F(1.5)$, so median lies between 1.4 and 1.5

$F(1.4) < F(Q2) < F(1.5)$, therefore $Q2$ lies between 1.4 and 1.5

$F(1.4) < F(m) < F(1.5)$, $1.4 < m < 1.5$

$F(1.4) < 0.5$, $F(1.5) > 0.5$, so median of X lies between 1.4 and 1.5

Allow equivalent comparisons for 4 and 0



Question Number	Scheme	Marks
5(a)	$d = 7$	B1
	$\frac{c}{3} - \frac{7}{6} = 1 - \frac{1}{6}("7" - c)^2$	M1
	$\frac{c}{3} - \frac{7}{6} = 1 - \frac{1}{6}("49" - 2 \times "7" c + c^2)$ oe or $c^2 - 12c + 36 = 0$ oe	dM1
	$(c - 6)^2 = 0 \therefore c = 6^*$	A1*
		(4)
(b)	$P(X > 3.5) = 1 - \frac{1}{6}(3.5 - 3)^2$	M1
	$= \frac{23}{24}$ oe awrt 0.958	A1
		(2)
(c)	$P(3.5 < X < 5.5) = \left(\frac{5.5}{3} - \frac{7}{6}\right) - \left(\frac{1}{6}(3.5 - 3)^2\right) \left[= \frac{5}{8} \right]$ oe	M1
	$P(X > 4.5 \mid 3.5 < X < 5.5) = \frac{\left(\frac{5.5}{3} - \frac{7}{6}\right) - \left(\frac{4.5}{3} - \frac{7}{6}\right)}{"5/8"}$	M1
	$= \frac{8}{15}$ oe awrt 0.533	A1
		(3)
Notes		Total 9
(a)	B1	realising $d = 7$
	M1	Forming an equation in c with their d or d
	dM1	Dependent on previous M1. Multiplying out brackets and would reduce to a 3 term quadratic correct for their d or d
	A1*	All previous marks must be awarded. For solving the correct 3TQ and statement
(b)	M1	Substitution of 3.5 into correct expression
	A1	Allow equivalent fractions or awrt 0.958
(c)	M1	Correct method to calculate $P(3.5 < X < 5.5)$ may use $1 - \frac{23}{24}$ for $\left(\frac{1}{6}(3.5 - 3)^2\right)$
		Useful figures are $\left(\frac{5.5}{3} - \frac{7}{6}\right) = \frac{2}{3}$ and $\left(\frac{1}{6}(3.5 - 3)^2\right) = \frac{1}{24}$
	M1	Correct method using their 5/8
		Useful figure is $\left(\frac{5.5}{3} - \frac{7}{6}\right) - \left(\frac{4.5}{3} - \frac{7}{6}\right) = \frac{1}{3}$
	A1	Allow equivalent fractions or awrt 0.533

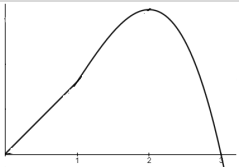
Question Number	Scheme	Marks
3. (a)	$\int_2^5 \frac{1}{48} (x^2 - 8x + c) dx = 1$ $1 = \frac{1}{48} \left[\frac{x^3}{3} - 4x^2 + cx \right]_2^5$ $1 = \frac{1}{48} \left(\left(\frac{5^3}{3} - 4(5^2) + 5c \right) - \left(\frac{2^3}{3} - 4(2^2) + 2c \right) \right) \quad \text{or} \quad 48 = 39 - 84 + 3c$ $(\Rightarrow 3c = 93 \Rightarrow c = 31^*)$	M1 M1 A1cso* (3)
(b)	$P(2 < X < 3) = \frac{1}{48} \left[\frac{x^3}{3} - 4x^2 + 31x \right]_2^3$ $\frac{1}{48} \left(\left(\frac{3^3}{3} - 4(3^2) + 31(3) \right) - \left(\frac{2^3}{3} - 4(2^2) + 31(2) \right) \right) = \frac{13}{36} \quad (= \text{awrt } 0.361)$	M1 A1 (2)
(c)	Less than 3 since " $\frac{13}{36}$ " > 0.25	B1 (1)
(d)	$x = 4$ leads to the minimum/lowest value of $f(x)$ / $f(x)$ is a positive quadratic	B1 (1)
(e)	Considers $x = 2$ and $x = 5$ by e.g. $f(2) = 0.39(58\dot{3}) [= \frac{19}{48}]$ and $f(5) = 0.\dot{3} [= \frac{16}{48}]$ (so $f(2) > f(5)$) - Sketch of $f(x)$ from $x = 2$ to $x = 5$ $x = 2$ is further than $x = 4$ (then $x = 5$) Mode is $x = 2$	M1 A1 (2)
[9 marks]		
Notes		
(a)	1 st M1 setting up integral and equating to 1 (condone missing dx) limits not needed 2 nd M1 attempting to integrate $f(x)$ at least one term $x^n \rightarrow x^{n+1}$ (need not be = 1) Use of integration of $f(x)$ with $F(2) = 0$ and $F(5) = 1$ can score M1M1 A1* cso including use of correct limits. There should be at least one line of working between scoring the 2 nd M1 and arriving at the given answer. Allow a verification method 1 st M1 setting up integral 2 nd M1 attempting to integrate A1cso use of correct limits to show that it integrates to 1 and concluding that $c = 31$	
(b)	M1 for use of integration of $f(x)$ $x^n \rightarrow x^{n+1}$ with correct limits 2 and 3 (ft from their (a)) A1 allow awrt 0.361 (correct answer scores 2 out of 2)	
(c)	B1 less than 3 with correct reasoning. May use their part (b), but must be consistent with 'less than 3' If the lower quartile is found awrt 2.67, allow $LQ/2.67 < 3$	
(d)	B1 correct reason why the method does not give the correct mode. Allow a sketch of $f(x)$. Also allow, e.g. 'Kei's method did not consider the end-points'	
(e)	M1 considers end-points A1 mode is 2 cao Answer only scores M0A0. Must have some justification.	

Question	Scheme		Marks
2(a)	$\frac{3}{10}d - \frac{1}{75}d^2 - \frac{2}{3} = 1$		M1
	$45d - 2d^2 - 100 = 150$ or $\frac{3}{10}d - \frac{1}{75}d^2 - \frac{5}{3} = 0 \rightarrow 2d^2 - 45d + 250 = 0^*$		A1*
			(2)
(b)	$P(1 < H < 4.5) = \left(\frac{4.5}{6} - \frac{1}{3}\right) - \left(\frac{1}{48}\right) = \frac{19}{48}$ or 0.39583...		M1
	$P(1 < H < 1.5) = \left(\frac{1.5^2}{48}\right) - \left(\frac{1}{48}\right) = \frac{5}{192}$ or 0.02604...		M1
	$P(H < 1.5 1 < H < 4.5) = \frac{"0.02604..."}{"0.3958..."}$		M1
	$= \frac{5}{76}$ or 0.06578... awrt 0.0658		A1
			(4)
(c)	$[f(h) =] \begin{cases} \frac{h}{24} & 0 < h, 4 \\ \frac{1}{6} & 4 < h, 5 \\ \frac{3}{10} - \frac{2}{75}h & 5 < h, d \\ 0 & otherwise \end{cases}$		M1 M1 A1
			(3)
Notes			Total 9
(a)	M1	for $\frac{3}{10}d - \frac{1}{75}d^2 - \frac{2}{3} = 1$	
	A1*	cso at least one step seen before given answer e.g. removing the denominator or correct 3 term quadratic = 0	
(b)	M1	correct method to find $P(1 < H < 4.5)$ implied by $\frac{19}{48}$ or awrt 0.396	
	M1	for writing or finding $P(1 < H < 1.5)$ implied by $\frac{5}{192}$ or awrt 0.026	
	M1	for $\frac{p}{"0.3958"}$ where $0 < p < "0.3958"$	
	A1	awrt 0.0658	
(c)	M1	for one of row 1, 2 or 3 correct. Allow any letters. Condone missing/incorrect range	
	M1	for any two rows correct with ranges. Allow any letters and < for ,, signs	
	A1	Fully correct. all the same letter in rows 1 to 3 Allow < for ,, signs condone $d = 10$ but not $d = 12.5$	

Question Number	Scheme		Marks
5 (a)	$\int_1^x \frac{1}{4}(3-t)dt = \frac{1}{4}\left[3t - \frac{t^2}{2}\right]_1^x$ or $\int \frac{1}{4}(3-x)dx = \frac{1}{4}\left[3x - \frac{x^2}{2}\right] + C$		M1
	$\frac{1}{4}\left[\left(3x - \frac{x^2}{2}\right) - \left(3 - \frac{1}{2}\right)\right]$ or $\frac{1}{4}\left[3(1) - \frac{(1)^2}{2}\right] + C = 0$ and $C = -\frac{5}{8}$ Leading to $\frac{1}{4}\left(3x - \frac{x^2}{2}\right) - \frac{5}{8}$ [for 1,, x,, 2]*		A1*
			(2)
(b)	$\int_2^x \frac{1}{4}dt + F(2)$ or $\int \frac{1}{4}dx$ and using + c with $F(2) = \frac{3}{8}$ or $0.25(x-2) + F(2)$		M1
	$\int_3^x \frac{1}{4}(t-2)dt + F(3)$ or $\int \frac{1}{4}(x-2)dx$ and using + c with either $F(3) = \frac{5}{8}$ or $F(4) = 1$		M1
	$F(x) = \begin{cases} 0 & x < 1 \\ \frac{1}{4}\left(3x - \frac{x^2}{2}\right) - \frac{5}{8} & 1 \leq x \leq 2 \\ \frac{1}{8}(2x-1) & 2 < x \leq 3 \\ \frac{1}{4}\left(\frac{x^2}{2} - 2x\right) + 1 & 3 < x \leq 4 \\ 1 & x > 4 \end{cases}$		A1 A1 B1
		(5)	
(c)	$P(1.2 < X < 3.1) = F(3.1) - F(1.2)$		
	$\left(\frac{1}{4}\left(\frac{(3.1)^2}{2} - 2(3.1)\right) + 1\right) - \left(\frac{1}{4}\left(3(1.2) - \frac{(1.2)^2}{2}\right) - \frac{5}{8}\right) = \frac{89}{160}$ awrt 0.556		M1 A1
			(2)
Notes			Total 9
(a)	M1	For a correct method for 1,, x,, 2 Condone poor notation e.g. $\int_1^x \frac{1}{4}(3-x)dx$	
	A1*	A fully correct solution with substitution seen or C found leading to $F(x) = \frac{1}{4}\left(3x - \frac{x^2}{2}\right) - \frac{5}{8}$	
(b)	M1	For a correct method for $2 < x \leq 3$	
	M1	For a correct method for $3 < x \leq 4$	
	A1	Third line correct including inequality. Allow < instead of $\leq$	
	A1	Fourth line correct including inequality. Allow < instead of $\leq$	
	B1	First and fifth line correct. Allow “otherwise” for the range on the first or fifth line but not both	
(c)	M1	For use of $F(3.1) - F(1.2)$ from the correct lines of their F(x) allow ft on their 4 th line or correct use of f(x) or area e.g. $\frac{1}{2} \times \frac{7}{10} \times 0.8 + 1 \times \frac{1}{4} + \frac{1}{2} \times \frac{21}{40} \times 0.1$	
	A1	For $\frac{89}{160}$ oe or awrt 0.556 NB: Use of $F(3.1)$ with $\frac{1}{8}(2x-1)$ for $2 < x \leq 3$ gives 0.555 and scores M0A0	

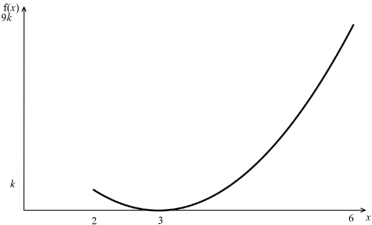
Question Number	Scheme		Marks
2(a)	$1 - F(3.5) = 1 - 0.97127\dots$		M1
	$= 0.028727\dots$	awrt 0.0287	A1
			(2)
(b)	$W \sim B(30, "0.0287")$		M1
	$1 - P(W \leq 1) = 1 - \left((1 - "0.0287")^{30} + {}^{30}C_1 ("0.0287")^1 (1 - "0.0287")^{29} \right)$ oe		M1
	$= 1 - 0.78748 \dots = 0.2125\dots$	awrt 0.213 to awrt 0.216	A1
			(3)
(c)	$\frac{dF(w)}{dw} = \frac{1}{3} \left(1 - \frac{w^3}{64} \right)$		M1
	$E(W^2) = \int_0^4 \frac{1}{3} \left(w^2 - \frac{w^5}{64} \right) dw = \frac{1}{3} \left[\frac{w^3}{3} - \frac{w^6}{384} \right]_0^4$		dM1
	$= \frac{32}{9}$		A1
	$\text{Var}(W) = \frac{32}{9} - 1.6^2$		M1
	$= \frac{224}{225}$		A1
			(5)
			Total 10
Notes			
(a)	M1	For writing or using $1 - F(3.5)$ Implied by correct answer	
	A1	awrt 0.0287	
(b)	M1	For writing or using $B(30, "0.0287")$ allow $n ("their 0.0287")^1 (1 - "their 0.0287")^{29}$ ignore any number for n (allow their p to 2sf)	
	M1	For $1 - \left((1 - "0.0287")^{30} + {}^{30}C_1 ("0.0287")^1 (1 - "0.0287")^{29} \right)$ Allow ${}^{30}C_{29}$ in any form	
	A1	allow answer in the range awrt 0.213 to awrt 0.216	
(c)	M1	Differentiating $F(w)$ at least one term correct	
	dM1	(Dep on previous M1). Attempting to integrate expanded $w^2 f(w)$. At least one $w^n \rightarrow w^{n+1}$ Ignore limits for this M mark.	
	A1	awrt 3.56 must come from correct algebraic integration (may be embedded)	
	M1	Use of correct formula with values substituted. Must see the subtraction of 1.6^2	
	A1	Dependent upon 2 nd M1 awrt 0.996 (A correct answer with no algebraic integration seen may score M1M0A0M1A0)	

Question Number	Scheme		Marks
4(a)	$\int_0^a k(a-x)^2 dx = \left[k \left(a^2 x - ax^2 + \frac{x^3}{3} \right) \right]_0^a \text{ or } \left[\frac{-k(a-x)^3}{3} \right]_0^a$		M1 A1
	$k \left(a^3 - a^3 + \frac{a^3}{3} \right) = 1 \text{ or } \frac{ka^3}{3} = 1 \Rightarrow ka^3 = 3$		A1 cso
			(3)
(b)	$\int_0^a kx(a-x)^2 dx = \left[k \left(\frac{a^2 x^2}{2} - \frac{2ax^3}{3} + \frac{x^4}{4} \right) \right]_0^a \text{ or } \left[\frac{-kx(a-x)^3}{3} + \frac{k(a-x)^4}{12} \right]_0^a$		M1A1
	$k \left(\frac{a^2 a^2}{2} - \frac{2aa^3}{3} + \frac{a^4}{4} \right) = 1.5 \text{ or } \left[\frac{ka(a)^3}{3} - \frac{k(a)^4}{12} \right]_0^a = 1.5 \text{ or } ka^4 = 18 \text{ oe}$		dM1
	$\frac{ka^4}{ka^3} = 6 \text{ or } \frac{18}{3} = 6 \quad [\therefore a = 6]$		A1cso
			(4)
(c)	$F(x) = \frac{1}{72} \left(36x - 6x^2 + \frac{x^3}{3} \right)$	$\frac{1}{72} \left(36x - 6x^2 + \frac{x^3}{3} \right) = 0.5 \text{ oe}$	M1
	$F(1.15)(= 0.47\dots)$ <u>and</u> $F(1.25) (= 0.5038\dots)$	1.2377...	M1
	$F(1.15) = \text{awrt } 0.47, F(1.25) = \text{awrt } 0.504$ ($0.47(18\dots) < 0.5 < 0.503(8\dots)$) therefore the median is 1.2 to 1 decimal place.	therefore the median is 1.2 to 1 decimal place.	A1
			(3)
Total 10			
Notes			
(a)	M1	Integrating $f(x)$ at least 1 term correct. For M1 allow $\frac{\pm k(a-x)^3}{3}$	
	A1	Correct integration (ignore limits)	
	A1cso	Substitute limits and equating to 1 to form one expression in terms of k and a leading to $ka^3 = 3$	
(b)	M1	Indicating that they are integrating $xf(x)$ with an attempt at integrating $x^n \rightarrow x^{n+1}$	
	A1	Correct integration	
	dM1	(dep on previous M1). Substitute limits and equating to 1.5 to form a 2 nd expression in terms of k and a	
	A1cso	Correct method shown to solve their 2 equations to eliminate k and show $a=6$	
(c)	M1	Finding correct $F(x)$. Allow $F(x) = 1 - \frac{(6-x)^3}{216}$ but $F(x) = \frac{(6-x)^3}{216}$ is M0 Allow in terms of k for this mark	
	M1	For attempting their $F(1.15)$ and their $F(1.25)$ or a suitable tighter interval or for ‘solving’ cubic leading to a value awrt 1.24	
	A1	Both correct values and correct conclusion (allow $x = 1.2$) or awrt 1.24 and correct conclusion (allow $x = 1.2$). Allow change of sign argument if they have subtracted 0.5 (i.e. $-0.028\dots < 0 < 0.0038\dots$).	

Question Number	Scheme	Marks
3(a)	$4a = a(b) \Rightarrow b = 4 *$	B1*cso
		(1)
(b)	$a(27b - 81 + 1) = 1$	M1
	$a = \frac{1}{28}$	A1
		(2)
(c)	$P(X > 2.25) = 1 - F(2.25)$	M1
	$= 0.25237....$ awrt 0.252	A1
		(2)
(d)(i)	$f(x) = \frac{3}{7}x^2 - \frac{1}{7}x^3$ or $\frac{2}{7}x$	M1
		B1
	Sketch	
(ii)	$f'(x) = \frac{6}{7}x - \frac{3}{7}x^2$	dM1
	$\frac{6}{7}x - \frac{3}{7}x^2 = 0$	dM1
	Mode = 2	A1
		(5)
		Total 10
	Notes	
	In this question award mark all parts together	
(a)	B1*	Answer given so need to see $4a = a(b)$ allow $4a(1) = a(b(1) - 1 + 1)$ followed by $b = 4$
(b)	M1 A1	For a correct equation 1/28 o.e.
(c)	M1 A1	For $1 - F(2.25)$ or $F(3) - F(2.25)$ Implied by a correct answer awrt 0.252
(d)(i)	M1 B1	Differentiating to find $f(x)$, one term correct or correct follow through. Condone missing a Differentiation may be seen anywhere in the question. $f(x) = a(12x^2 - 4x^3)$ or $8ax$
	dM1	Sketch of pdf. Straight line followed by smooth curve with mode near the middle of the curve. Must be connected (no gap). Values not required, but must begin and end on horizontal axis.
(ii)	dM1 A1	Dep on 1st M being awarded. Differentiating their $f(x)$ (for $1 < x \leq 3$) to find $f'(x)$ $x^n \rightarrow x^{n-1}$ Condone missing a $f'(x) = a(24x - 12x^2)$ Dep on previous M being awarded. Putting their $f'(x) = 0$ All but the B1 mark must be awarded

Question Number	Scheme		Marks
4 (a)	$\frac{9}{20}$		B1
			(1)
(b)	$(21k - k) \times \frac{\pi}{20} = 1$		M1
	$k = \frac{1}{\pi} *$		A1*
			(2)
(c) (i)	$\left[E(X) = \frac{1}{2}(k + 21k) \right] = \frac{11}{\pi}$		B1
(ii)	$\text{Var}(X) = \frac{1}{12}(21k - k)^2$	or $\text{Var}(X) = \int_{\frac{1}{\pi}}^{\frac{21}{\pi}} \frac{\pi}{20} x^2 dx - \left(\frac{11}{\pi} \right)^2$	M1
	$= \frac{100}{3\pi^2}$		A1
			(3)
(d)	$E(A) = \pi E(X^2) + 4E(X) + \frac{4}{\pi}$	$E(A) = \int_k^{21k} f(x)(A) dx = \int_k^{21k} \frac{\pi}{20} (\pi) \left(x^2 + \frac{4}{\pi} x + \frac{4}{\pi^2} \right) dx$	M1
	$E(X^2) = \frac{100}{3\pi^2} + \left(\frac{11}{\pi} \right)^2 = \frac{463}{3\pi^2}$	$E(A) = \frac{\pi}{20} (\pi) \left(\frac{x^3}{3} + \left(\frac{4}{\pi} \right) \frac{x^2}{2} + \frac{4}{\pi^2} x \right)$	M1
	$E(A) = \frac{463}{3\pi} + \frac{44}{\pi} + \frac{4}{\pi}$	sub limits $\frac{21}{\pi}$ and $\frac{1}{\pi}$	M1
	$= \frac{607}{3\pi}$	$= \text{awrt } 64.4$	A1
			(4)
Notes			Total 10
(a)	B1	0.45oe cao	
(b)	M1	use of the area of the rectangle = 1 Any equivalent rearrangement, allow 20k instead of (21k - k)	
	A1*	answer is given so a fully correct solution must be seen	
(c)(i)	B1	oe must be in terms of π (isw after correct answer seen)	
(ii)	M1	use of $\frac{(b-a)^2}{12}$ or $\text{Var}(X) = \int_{\frac{1}{\pi}}^{\frac{21}{\pi}} \frac{\pi}{20} x^2 dx - \left(\frac{11}{\pi} \right)^2$	
	A1	for $\frac{100}{3\pi^2}$ oe must be in terms of π (isw after correct answer seen)	
	SC	If both final answers are given in terms of k, score B1M1A0 for (c)(i) 11k and (c)(ii) $\frac{100}{3} k^2$	
(d)	M1	for expanding $E(A) = E \left(\pi X^2 + 4X + \frac{4}{\pi} \right)$ or for setting up correct integral (ignore limits)	
	M1	Valid method for finding $E(X^2)$ i.e. use of $\text{Var}(X) + E(X)^2$ or integration of $x^2 f(x)$ or for integration of their $f(x)A$ with at least one $x^n \rightarrow x^{n+1}$	
	M1	substitution of their $E(X)$ and their $E(X^2)$ into their $E(A)$ or for use of correct limits	
	A1	for $\frac{607}{3\pi}$ or awrt 64.4	

Question Number	Scheme		Marks
4(i)(a)	$E(X^2) = \int_1^3 x^2 \times \frac{x^3}{20} \, dx \left(= \int_1^3 \frac{x^5}{20} \, dx \right)$ $= \left[\frac{x^6}{120} \right]_1^3$ $= \frac{729}{120} - \frac{1}{120} = \frac{91}{15}$		M1 A1 A1
			(3)
(b)	$\text{Var}(E) = "E(X^2)" - (2.42)^2$ $= \frac{91}{15} - (2.42)^2 = 0.21026...$ awrt 0.210		M1 A1ft
			(2)
(ii)(a)	No smaller than Q_3 , $S \sim B(10, 0.75)$ $P(S \leq 7) = 1 - P(S \leq 6)$ $= 1 - 0.22412...$ $= 0.77587...$ awrt 0.776	Alt: No larger than Q_3 , $L \sim B(10, 0.25)$ $P(L \leq 3)$ $= 0.77587...$ (tables give 0.7759) awrt 0.776	B1 M1 A1
			(3)
(b)	$P(S \leq 5) = 1 - P(S \leq 4)$ $= 1 - 0.019727...$ $= 0.98027...$	$P(L \leq 5)$ $= 0.98027...$ (tables give 0.9803) awrt 0.980	M1 A1
			(2)
	Notes		Total 10
(i)(a)	M1	correct method stated or implied condone missing limits	
	A1	$\frac{x^6}{120}$ correct and correct limits shown or used (which may be implied by final answer)	
	A1	$\frac{91}{15}$ oe (provided $\frac{x^6}{120}$ oe seen). May be seen in (b).	
(b)	M1	correct calculation ft their $E(X^2)$ from (a)	
	A1ft	awrt 0.210 accept $\frac{1577}{7500}$ Correct answer 2/2. Condone 0.21 with working seen ft if (a) is rounded to 6.07 leading to awrt 0.214	
(ii)(a)	B1	B(10, 0.75) or B(10, 0.25) oe stated in either (ii)(a) or (ii)(b), or implied by a correct probability in (ii)(a) or (ii)(b)	
	M1	correct probability statement for their B(10, p), where $p = 0.25$ or $p = 0.75$ or allow if Po(10 p) used. Implied by correct answer.	
	A1	awrt 0.776	
(b)	M1	correct probability statement for their B(10, p), where $p = 0.25$ or $p = 0.75$ or allow if Po(10 p) used. Implied by correct answer.	
	A1	awrt 0.980 (condone 0.98 with correct working seen)	

Question Number	Scheme		Marks
7 (a)	 Correct shape Fully correct including labels for 2, 3, 6, k and $9k$. Must be on the sketch		M1 A1 (2)
(b)	Mode = 6		B1 (1)
(c)(i)	$\int k(x-3)^2 dx = 1$		M1
	$k \int_2^6 x^2 - 6x + 9 dx = k \left[\frac{1}{3}x^3 - 3x^2 + 9x \right]_2^6$ or $k \left[\frac{1}{3}(x-3)^3 \right]_2^6$	Alt method $\Rightarrow k \left(\frac{1}{3}x^3 - 3x^2 + 9x \right) + c$	M1
	$18k - \frac{26k}{3} = 1 \text{ or } 9k - \frac{k}{3} = 1$	$k \left(\frac{1}{3}(2)^3 - 3(2)^2 + 9(2) \right) + c = 0$ $\Rightarrow c = -\frac{26}{3}k$ $k \left(\frac{1}{3}(6)^3 - 3(6)^2 + 9(6) \right) - \frac{26}{3}k = 1$	dM1
	e.g. $\frac{28k}{3} = 1 \quad \therefore k = \frac{3}{28} *$		A1*
			(4)
(ii)	$\frac{3}{28} \int_2^{5.71} x^2 - 6x + 9 dx = 0.7465... \text{ and}$ $\frac{3}{28} \int_2^{5.72} x^2 - 6x + 9 dx = 0.7544...$ e.g. $0.7465... < 0.75 < 0.7544... \text{ therefore}$ $5.71 < Q_3 < 5.72 \text{ oe}$	$\frac{3}{28} \int_{5.71}^6 x^2 - 6x + 9 dx = 0.25348... \text{ and}$ $\frac{3}{28} \int_{5.72}^6 x^2 - 6x + 9 dx = 0.24558...$ e.g. $0.24558... < 0.25 < 0.25348... \text{ therefore}$ $5.71 < Q_3 < 5.72 \text{ oe}$	M1 dM1 A1 (3)
Alt(ii)	$\frac{3}{28} \int_2^{5.71} x^2 - 6x + 9 dx - 0.75 = -0.003...$ $\frac{3}{28} \int_2^{5.72} x^2 - 6x + 9 dx - 0.75 = 0.004...$ e.g. there is a change of sign therefore Q_3 lies between 5.71 and 5.72 oe	$\frac{3}{28} \int_{5.71}^6 x^2 - 6x + 9 dx - 0.25 = 0.003...$ $\frac{3}{28} \int_{5.72}^6 x^2 - 6x + 9 dx - 0.25 = -0.004...$	M1 dM1 A1 (3)
			(3)
			Total 10

		Notes
(a)	M1	for correct positive quadratic shape in first quadrant ignore labelling with a minimum point on the x -axis. End point on the lhs should be lower than the end point on rhs. Condone poor curvature but not straight lines provided the intention is clear
	A1	fully correct including the coordinates $(2, k)$ (accept $(2, \frac{3}{28})$), $(3, 0)$ and $(6, 9k)$ (accept $(6, \frac{27}{28})$) shown on sketch. Labels on axes are sufficient.
(b)	B1	mode = 6 only
(c)(i)	M1	correct integral set equal to 1. May be seen or implied in later work. Does not require limits.
	M1	attempt to expand brackets and integrate with at least one x^{n+1} term. Ignore coefficients of terms. May attempt to integrate $(x-3)^2 \rightarrow (x-3)^3$. Does not require limits
	dM1	dep on both previous M marks for use of correct limits proceeding to a linear equation in k set equal to 1 or implied.
	A1*	cso including correct use of brackets. Must show some evidence of evaluation after substituting in limits before proceeding to $k = \frac{3}{28}$. e.g. $k \left(\frac{1}{3}(6-3)^3 - \frac{1}{3}(2-3)^3 \right) = 1 \Rightarrow k = \frac{3}{28}$ is A0*
Alt(c)(i)	M1	correct integral set equal to 1. May be seen or implied in later work. Does not require limits.
	M1	attempt to expand brackets and integrate with at least one x^{n+1} term. Ignore coefficients of terms. May attempt to integrate $(x-3)^2 \rightarrow (x-3)^3$. Does not require limits.
	M1	for substituting $x = 2$ into their integrated expression and set equal to 0 to find c in terms of k $\left(-\frac{26k}{3} \right)$ Then substitutes in $x = 6$ and set equal to 1 achieves a linear equation in k . (or the opposite way round using $x = 6$ and setting equal to 1 to find c and then substituting $x = 2$ and setting equal to 0)
	A1*	cso including correct use of brackets. Must show some evidence of evaluation after substituting in $x = 6$ (or $x = 2$ if the other way round) before proceeding to $k = \frac{3}{28}$.
(ii)	M1	1 calculation attempted, ie attempting to evaluate 1 definite integral with the correct limits. Implied by awrt 0.747 (or allow 0.746) or awrt 0.754 or awrt 0.253 or awrt 0.246 (allow 0.245)
	dM1	dep on 1 st M for 2 calculations attempted. Implied by both correct values to 3sf
	A1	for correct values awrt 0.747 (or allow 0.746) and awrt 0.754 (or awrt 0.253 and awrt 0.246 (allow 0.245)), comparisons and justification of Q_3 . Must refer to the upper quartile oe. Not just e.g. x . Do not penalise mislabelling of their functions.
Alt(ii)	M1	1 calculation attempted, ie attempting to evaluate 1 definite integral with the correct limits and subtracting 0.75 or 0.25 as appropriate
	dM1	dep on 1 st M for 2 calculations attempted (imp. by correct values rounded to 1sf or truncated)
	A1	for correct values (rounded or truncated), comparisons and justification of Q_3 . Must refer to the upper quartile oe. Not just e.g. x . The comparisons with 0 may be done in their working. Do not penalise mislabelling of their functions.
		Note: May substitute 5.71 and 5.72 into $a^3 - 9a^2 + 27a - 47 = 0$ instead proceeding to values of $-0.0974...$ and $0.12364...$
(ii)	SC M1dM1 A0	Integrates, sets equal to 0.75 and solves with a justification of Q_3 : $\frac{3}{28} \int_2^a x^2 - 6x + 9 \, dx = 0.75 \Rightarrow \frac{3}{28} \left[\frac{1}{3}x^3 - 3x^2 + 9x \right]_2^a = 0.75 \Rightarrow a = 5.714...$ $(= a^3 - 9a^2 + 27a - 47 = 0) \Rightarrow a = \text{awrt } 5.714$ $5.71 < 5.714 < 5.72$ therefore $5.71 < Q_3 < 5.72$ oe

Question	Scheme	Marks
2. (a)	$E(T) = \int_0^4 \frac{1}{192} t(t^3 - 48t + 128) dt$	M1
	$= \frac{1}{192} \left[\frac{t^5}{5} - 16t^3 + 64t^2 \right]_0^4$ or $\left[\frac{t^5}{960} - \frac{1}{12} t^3 + \frac{1}{3} t^2 \right]_0^4$ oe	dM1
	$= \frac{1}{192} \left(\frac{4^5}{5} - 16(4^3) + 64(4^2) - 0 \right) = \frac{16}{15} \text{ min} \rightarrow 1 \text{ minute } 4 \text{ seconds}$	A1
		(3)
(b)	$P(\text{call takes between 1 and 3 minutes}) = \int_1^3 \frac{1}{192} (t^3 - 48t + 128) dt$	
	or $\left[\frac{t^4}{768} - \frac{1}{8} t^2 + \frac{2}{3} t \right]_1^3$ oe	M1
	$= \frac{1}{192} \left(\left(\frac{3^4}{4} - 24(3^2) + 128(3) \right) - \left(\frac{1^4}{4} - 24(1^2) + 128(1) \right) \right) = \frac{7}{16} *$	dM1 A1* _{cso}
		(3)
(c)	$C \sim B(256, \frac{7}{16}) \approx N(112, 63)$	M1 A1
	$P(C > 125) \approx P\left(Z > \frac{125.5 - 112}{\sqrt{63}}\right)$	M1M1
	$P(Z > 1.70) = 1 - 0.9554 = 0.0446$	A1
		(5)
	Notes	[11 marks]
(a)	1 st M1 for using $\int t f(t) dt$ ignore limits. $t^4 \rightarrow t^5$ or $t^2 \rightarrow t^3$ or $t \rightarrow t^2$ for at least one term, ignore coefficients. Implied by an answer of $\frac{16}{15}$ or 1 minute 4 seconds (allow 64) or awrt 1.067	
	2 nd dM1 dep on previous M1 fully correct integration with limit of 4 and 0 or 4 substituted (204.8) This mark is not implied by a correct answer	
	A1 the second M1 mark must be awarded 1 min 4 s (accept 64)	
	NB an answer of $\frac{16}{15}$ or 1 minute 4 seconds or 64 or awrt 1.067 with no working gains M1M0A0.	
(b)	1 st M1 attempt to integrate $\int f(t) dt$ $t^n \rightarrow t^{n+1}$ for at least one term. Ignore limits. If they have integrated $f(t)$ in part (a) and used this in part (b) we will allow this mark.	
	2 nd M1 (dep on 1 st M1) for use of correct limits. Must see substitution into their expression. If integration correct allow $\frac{1}{192} \left(\left(\frac{81}{4} - 216 + 384 \right) - \left(\frac{1}{4} - 24 + 128 \right) \right)$ or $\frac{1}{192} \left(\frac{753}{4} - \frac{417}{4} \right)$ or $\frac{251}{256} - \frac{139}{256}$	
	1 st A1* _{cso} $\frac{7}{16} [= 0.4375]$ fully correct solution (correct integration and substitution) . Answer is given so both method marks must be awarded.	
(c)	1 st M1 use or sight of Normal approximation with mean 112	
	1 st A1 correct mean and variance (condone 63 ² if used $\sqrt{63}$ in the standardisation)	
	2 nd M1 standardising using their mean and variance. Allow use of 124.5, 125, 125.5, 126, 126.5 or on the numerator 12.5, 13, 13.5, 14, 14.5	
	3 rd M1 use of continuity correction 125 ± 0.5 Implied by numerator of 12.5 or 13.5	
	2 nd A1 awrt 0.0445/0.0446 [calc 0.0444865...] [Exact binomial gives 0.0448518... and gains no marks]	

Question Number	Scheme		Marks
1(a)	[F(1) = 1 so] $k(6 \times 1^2 - 1^4) = 1$ leading to $k = \frac{1}{5}$ *		B1*
			(1)
(b)	$[1 - F(0.6) =] 1 - \frac{1}{5}(6 \times 0.6^2 - 0.6^4)$		M1
	$= 0.59392$ awrt 0.594		A1
			(2)
(c)(i)	$\frac{1}{5}(6m^2 - m^4) = \frac{1}{2}$		M1
	$2m^4 - 12m^2 + 5 = 0$ oe		A1
(ii)	$m = 0.6711\dots$ awrt 0.671		A1
			(3)
(d)	$\left[\frac{d}{dx} \left(\frac{6}{5}x^2 - \frac{1}{5}x^4 \right) = \right] \frac{12}{5}x - \frac{4}{5}x^3$		M1
	$\left[\frac{d}{dx} \left(\frac{12}{5}x - \frac{4}{5}x^3 \right) = \right] \frac{12}{5} - \frac{12}{5}x^2 = 0$		M1
	$x = 1$		A1
			(3)
(e)	Mean < “Median” < “Mode”		M1
	So negative [skew]		A1ft
			(2)
	Notes		Total 11
(a)	B1*	for use of F(1) = 1 leading to the given answer (minimum required is $k(6 - 1) = 1$) Allow use of F(1) – F(0) = 1 e.g. $k(6 - 1) - k(0 - 0) = 1$ The answer is given so no incorrect working can be seen	
(b)	M1	for using $1 - F(0.6)$ May be implied by $1 - \frac{1269}{3125}$ or $\frac{1856}{3125}$	
	A1	awrt 0.594 Allow $\frac{1856}{3125}$	
(c)(i)	M1	for setting F(m) = 0.5 Allow any letter (including x)	
	A1	for a correct 3TQ oe NB the values of a, b and c must be integers	
(ii)	A1	awrt 0.671 Allow $\sqrt{\frac{6 - \sqrt{26}}{2}}$ (must reject other roots if seen) NB It is possible to score M1A0A1	
(d)	M1	for differentiating F(x) with at least one $x^n \rightarrow x^{n-1}$ May be left in terms of k eg. $k(12x - 4x^3)$ Condone missing k	
	M1	for differentiating twice with at least one $x^n \rightarrow x^{n-1}$ and setting = 0 oe May be left in terms of k eg. $k(12 - 12x^2)=0$ Condone missing k	
	A1	Cao (Must reject $x = -1$ if seen)	
(e)	M1	a correct justification using the Mean and their Median and/or their Mode. This must be correct for their values Allow use of figures e.g. $0.64 < “0.671” < “1”$ Allow comparisons of “median” and “mode” on its own. Comparison with 0.5 is M0 unless 0.5 is their median or mode	
	A1ft	a correct conclusion based on their comparison (Do not allow a conclusion that is not fully supported by their comparison)	

Question Number	Scheme			Marks
5(a)	$\frac{2}{21} \int_0^k x \, dx +$ $\frac{2}{15} \int_k^6 (6-x) \, dx = 1$	$\frac{1}{2}(k-0) \times \frac{2}{21}k$ and $\frac{1}{2}(6-k) \times \frac{2}{15}(6-k)$	For $0 \leq x \leq k$ $F(x) = \frac{1}{21}x^2$	M1
	$\frac{2}{21} \left[\frac{x^2}{2} \right]_0^k +$ $\frac{2}{15} \left[6x - \frac{x^2}{2} \right]_k^6 [=1]$	$\frac{1}{2}(k-0) \times \frac{2}{21}k +$ $\frac{1}{2}(6-k) \times \frac{2}{15}(6-k) = 1$	For $k < x \leq 6$ $F(x) = \frac{2}{15} \left(6x - \frac{x^2}{2} \right) - \frac{7}{5}$ oe	M1
	$\frac{1}{21}k^2 +$ $\frac{2}{15} \left(18 - \left(6k - \frac{k^2}{2} \right) \right) [=1]$	$\frac{1}{21}k^2 +$ $\frac{1}{15}(36 - 12k + k^2) [=1]$ oe	$\frac{1}{21}x^2 = \frac{2}{15} \left(6x - \frac{x^2}{2} \right) - \frac{7}{5}$	dM1
	$4k^2 - 28k + 49 = 0$ oe			dM1
	e.g. $(2k-7)^2 = 0$ leading to $k = 3.5^*$			A1*
				(5)
	(b)	$E(X) = \frac{2}{21} \int_0^{3.5} x^2 \, dx + \frac{2}{15} \int_{3.5}^6 (6x - x^2) \, dx$		
$\frac{2}{21} \left[\frac{x^3}{3} \right]_0^{3.5} + \frac{2}{15} \left[3x^2 - \frac{x^3}{3} \right]_{3.5}^6$			dM1	
$\frac{2}{21} \left(\frac{343}{24} \right) + \frac{2}{15} \left(36 - \left(\frac{147}{4} - \frac{343}{24} \right) \right) = \frac{19}{6}$			dM1A1	
			(4)	
(c)	$\text{Var}(X) = \frac{277}{24} - \left(\frac{19}{6} \right)^2 = \frac{109}{72}$			M1A1
				(2)
Notes				Total 11
(a)	M1	for writing/using the integral of $f(x)$ and setting = 1 ignore limits or both areas identified (these do not need to be added nor set = 1) or a correct expression for $F(x)$ between $0 \leq x \leq k$		
	M1	for an attempt at integration on either part with $x^n \rightarrow x^{n+1}$ ignore limits or adding the area of the 2 triangles and set = 1 or a correct expression for $F(x)$ between $k \leq x \leq 6$		
	dM1	dependent on 1 st M1 for substitution of k , 0 and 6 into the integral of $f(x)$ or an un-simplified 3TQ quadratic or setting the 2 parts of $F(x)$ equal to each other		
	dM1	dependent on previous M1 for a correct 3TQ equal to 0 e.g. $\frac{4}{35}k^2 - \frac{12}{15}k + \frac{7}{5} = 0$ oe		
	A1*	for solving the 3TQ leading to the given answer (Working must be shown)		

NB Solution based on the assumption that $\frac{2}{21}k = \frac{2}{15}(6-k)$ scores M0M0dM0dM0A0

e.g. $\frac{2}{21}k = \frac{2}{15}(6-k)$ or $\frac{1}{2} \times 6 \times \frac{2}{21}k = 1$ or $\frac{1}{2}(k-0) \times \frac{2}{21}k + \frac{1}{2}(6-k) \times \frac{2}{21}k = 1$

Use of verification can score M1M1dM0dM0A0

e.g. $\frac{2}{21} \left[\frac{x^2}{2} \right]_0^{3.5} + \frac{2}{15} \left[6x - \frac{x^2}{2} \right]_{3.5}^6 [=1]$ or $\frac{1}{2}(3.5-0) \times \frac{2}{21}(3.5) + \frac{1}{2}(6-3.5) \times \frac{2}{15}(6-3.5) = 1$

(b)	M1	for writing or using the integral of $xf(x)$ ignore limits but must be both parts
	dM1	dependent on 1 st M1 for an attempt at integration on both parts with $x^n \rightarrow x^{n+1}$ ignore limits
	dM1	dependent on previous M1 for substitution of 3.5, 0 and 6 ($\frac{49}{36}$ and $\frac{65}{36}$ is the minimum required to imply this mark)
	A1	allow awrt 3.17
(c)	M1	for use of $E(X^2) - E(X)^2$ ft their $E(X)$
	A1	allow awrt 1.51

Question Number	Scheme		Marks
5 (a)	Complaints received are independent or occurring at a constant rate or singly		B1
			(1)
(b)(i)	$\left[P(X < 3 X \sim \text{Po}(6)) = \right]$ 0.0620	awrt 0.062	B1
(ii)	$\left[P(X \geq 6) = \right]$ $1 - P(X \leq 5)$ or $1 - 0.4457 = 0.5543$	awrt 0.554	M1A1
			(3)
(c)	$H_0 : \lambda = 6 \quad H_1 : \lambda > 6$		B1
	$P(X \geq 12) = 1 - P(X \leq 11) = [1 - 0.9799]$ or $P(X \geq 11) = 1 - P(X \leq 10) = [1 - 0.9574]$		M1
	$= 0.0201$ or $CR \geq 11$		A1
	Reject H_0 /In the CR/Significant		M1
	There is sufficient evidence to suggest that the mean number of complaints received is greater than 6 per week		A1ft
			(5)
(d)	$H_0 : \lambda = 6 \quad H_1 : \lambda < 6$		B1
	6 week period is $\text{Po}(36) \Rightarrow N(36, 36)$		B1
	$P(Y \leq 26) \approx P(Y < 26.5) = P\left(Z < \frac{26.5 - 36}{6}\right)$ or $\frac{x + 0.5 - 36}{\sqrt{36}} < -1.6449$		M1 M1
	$\left[P(Z < -1.583...) \right] = 0.0571$ (Calculator 0.05667...) or $x < 25.63...$		A1
	awrt 0.057	awrt 25.6	
	Do not reject H_0 /Not in the CR/Not significant		M1
	There is insufficient evidence to suggest that the mean number of complaints received after the changes made is less than 6 per week		A1ft
			(7)
Notes			Total 16
(a)	B1	A correct assumption. Must be in context so need ‘complaints’ and then independent/random or constant rate or singly	
(b)(i)	B1	awrt 0.062	
(ii)	M1	For writing or using $1 - P(X \leq 5)$ May be implied by awrt 0.554	
	A1	awrt 0.554	
(c)	B1	Both hypotheses correct. Must be attached to H_0 and H_1 in terms of λ or μ	
	M1	For writing or using $1 - P(X \leq 11)$ or $1 - P(X \leq 10)$	
	A1	For 0.0201 or $CR \geq 11$	
	M1	A correct statement – no context needed but do not allow contradicting non contextual comments	
	A1ft	Correct conclusion in context with the words highlighted in bold	
(d)	B1	Both hypotheses correct. Must be attached to H_0 and H_1 in terms of λ or μ Allow use of 36 rather than 6	
	B1	For writing or using $N(36, 36)$	
	M1	For standardising using 25.5/26/26.5, their mean and their standard deviation or standardising using $x - 0.5/x + 0.5$, their mean and their standard deviation and setting equal to -1.6449	
	M1	For a correct continuity correction written or used e.g. 26.5 or $x + 0.5$	
	A1	awrt 0.057 (NB Poisson used gives 0.0512685... and scores M0M0A0) or $CR < \text{awrt } 25.6$ (Allow $\leq$)	
	M1	A correct statement – no context needed but do not allow contradicting non contextual comments	
	A1ft	Correct conclusion in context with the words in bold (Allow The mean number of complaints has stayed the same/not changed oe)	

Question Number	Scheme		Marks
6(a)	$\left[P\left(Y < \frac{1}{4}k \mid Y < k \right) \right] = \frac{F\left(\frac{1}{4}k \right)}{F(k)} = \frac{\frac{1}{21}\left(\frac{k}{4} \right)^2}{\frac{1}{21}k^2} = \frac{1}{16} \text{ oe}$		M1 A1
			(2)
(b)	$\frac{1}{21}k^2 = -\frac{1}{15}k^2 + \frac{4}{5}k - \frac{7}{5}$	$\frac{d}{dy}\left(\frac{1}{21}y^2 \right) = \frac{2}{21}y$ or $\frac{d}{dy}\left(\frac{2}{15}\left(6y - \frac{y^2}{2} \right) - \frac{7}{5} \right) = \frac{2}{15}(6-y)$	M1
	$\Rightarrow 4k^2 - 28k + 49 = 0$ oe	$\frac{d}{dy}\left(\frac{1}{21}y^2 \right) = \frac{2}{21}y$ & $\frac{d}{dy}\left(\frac{2}{15}\left(6y - \frac{y^2}{2} \right) - \frac{7}{5} \right) = \frac{2}{15}(6-y)$	A1
	$\Rightarrow (2k - 7)^2 = 0$	$\frac{2}{21}k = \frac{2}{15}(6-k)$	M1
	$k = \frac{7}{2}$ oe		A1
			(4)
(c)	$f(y) = \begin{cases} \frac{2}{21}y & 0 \leq y \leq '3.5' \\ \frac{2}{15}(6-y) & '3.5' < y \leq 6 \\ [0] & [\text{otherwise}] \end{cases}$		M1 M1
	$E(Y) = \frac{2}{21} \int_0^{'3.5'} y^2 dy + \frac{2}{15} \int_{'3.5'}^6 (6y - y^2) dy \Rightarrow \frac{2}{21} \left[\frac{y^3}{3} \right]_0^{'3.5'} + \frac{2}{15} \left[3y^2 - \frac{y^3}{3} \right]_{'3.5'}^6$		M1 M1
	$\frac{2}{21} \left(\frac{343}{24} \right) + \frac{2}{15} \left(\frac{325}{24} \right) = \frac{19}{6} = 3.166...$		awrt 3.17
			dM1 dA1
			(6)
Total 12			
(a)	M1	For a correct probability statement or a correct ratio of probabilities	
	A1	For $= \frac{1}{16}$ oe or 0.0625	
(b)	M1	For setting the two lines of the cdf = to each other or $\frac{2}{21}y$ or $\frac{2}{15}(6-y)$ (Implied by a correct 3TQ)	
	A1	For a correct 3TQ or $\frac{2}{21}y$ and $\frac{2}{15}(6-y)$	
	M1	For solving their 3TQ. If the 3TQ is not correct, then a correct method must be shown or setting their 2 lines of the pdf = to each other	
	A1	$k = 3.5$ oe NB $k = 3.5$ with no incorrect working scores 4/4	
(c)	M1	Attempting to differentiate 1 of the functions. May be seen in part (b) or in an attempt to find E(Y)	
	M1	Attempting to differentiate both with one correct. May be seen in part (b) or in an attempt to find E(Y)	
	M1	For writing or using $E(Y) = \int_0^{3.5} y f(y) dy + \int_{3.5}^6 y f(y) dy$ Ignore limits	
	M1	For attempting to integrate	
	dM1	Dependent on previous M1. For substitution of limits, must be 0 or 6 and ft their 3.5. May be implied by $\frac{49}{36}$ oe or $\frac{65}{36}$ oe or $\frac{19}{6}$ oe. If the integral is not correct, then we must see evidence of substitution.	
	dA1	Dependent on previous M1. For $\frac{19}{6}$ or awrt 3.17	

Number		
4 (a)		M1 A1
		(2)
(b)	$[P(G \leq 2) = 1 - 2 \times \frac{3}{20} = 0.7] \text{ or } \frac{1}{2} \times 3 \times \left(\frac{2}{15} + \frac{1}{3} \right) \text{ or } \frac{1}{15} \int_{-1}^2 (g+3) dg = 0.7] \text{ or}$ $\frac{1}{30} \times 2^2 + \frac{1}{5} \times 2 + \frac{1}{6} = 0.7]$ or $\left[P\left(G \leq \frac{1}{2}\right) = \frac{1}{2} \times 1.5 \times \left(\frac{2}{15} + \frac{3.5}{15} \right) = 0.275 \right] \text{ or } \frac{1}{15} \int_{-1}^{0.5} (g+3) dg = 0.275] \text{ or}$ $\frac{1}{30} \times 0.5^2 + \frac{1}{5} \times 0.5 + \frac{1}{6} = 0.275]$ or $\left[P\left(\frac{1}{2} \leq G \leq 2\right) = \frac{1}{2} \times 1.5 \times \left(\frac{7}{30} + \frac{1}{3} \right) = 0.425 \right] \text{ or } \frac{1}{15} \int_{0.5}^2 (g+3) dg = 0.425] \text{ or}$ $\frac{1}{30} \times (2^2 - 0.5^2) + \frac{1}{5} \times (2 - 0.5) = 0.425]$	M1
	$[P(1 \leq 2G \leq 6 G \leq 2) = \frac{P\left(\frac{1}{2} \leq G \leq 2\right)}{P(G \leq 2)} = \frac{0.425}{0.7} \text{ or } 1 - \frac{0.275}{0.7} \text{ oe}]$	M1M1
	$= \frac{17}{28} \text{ or } 0.607... \quad \text{awrt } 0.607$	A1
		(4)
(c)	$[E(H^2) = 2.4 + 12^2 = 146.4]$	M1
	$[E(G) = \int_{-1}^2 \frac{1}{15}(g^2 + 3g) dg + \int_2^4 \frac{3}{20} g dg]$	M1
	$[E(G) = \left(\frac{1}{15} \left(\frac{1}{3} g^3 + \frac{3}{2} g^2 \right) \right)_{-1}^2 + \left(\frac{3}{40} g^2 \right)_2^4]$	M1
	$= \frac{1}{15} \left(\frac{8}{3} + \frac{12}{2} + \frac{1}{3} - \frac{3}{2} \right) + \left(\frac{48}{40} - \frac{12}{40} \right) = 1.4]$	dM1
	$[E(2H^2 + 3G + 3) = 2 \times 146.4 + 3 \times 1.4 + 3]$	M1
	$= 300$	A1 (6)
		Total 12

		Notes
(a)	M1	for correct shape $\left(g = \frac{3}{20} \text{ must be below } \frac{1}{3}\right)$ with the lines not joining at $x = 2$ and none below/touch the x -axis. Ignore any broken/dotted lines drawn
	A1	for fully correct graph with labels on the x axis
(b)	M1	For a correct method to find $P(G, 2)$ or $P\left(G, \frac{1}{2}\right)$ or $P\left(\frac{1}{2}, G, 2\right)$ May be implied by $0.7 / \frac{7}{10}$ or $0.425 = \frac{17}{40}$ or $0.275 / \frac{11}{40}$
	M1	for $\frac{p}{0.7}$ where $0 < p < 0.7$ or $\frac{0.425}{q}$ where $0.425 < q < 1$ or $1 - \frac{0.275}{r}$ where $0.275 < r < 1$ Allow un-simplified probabilities
	M1	For $\frac{P\left(\frac{1}{2}, G, 2\right)}{P(G, 2)}$ or a correct ratio of probabilities
	A1	$\frac{17}{28}$ oe or awrt 0.607
(c)	M1	for a correct method to find $E(H^2)$
	M1	for realising $\int xf(x)dx$ on both functions and adding together. Ignore limits
	M1	for attempting to integrate $(x^n \rightarrow x^{n+1})$ at least one part of $xf(x)$
	dM1	dep on previous M1 being awarded. For use of correct limits in one part of $xf(x)$ If working not shown, then this may be implied by 0.5 or 0.9 or 1.4. If integration is incorrect then working must be shown.
	M1	For using $2 \times \text{their } E(H^2) + 3 \times \text{their } E(G) + 3$, provided $E(H^2)$ and $E(G)$ have been shown. NB You may have to check their answer if no working is shown for $2 \times \text{their } E(H^2) + 3 \times \text{their } E(G) + 3$
	A1	Cao

Question Number	Scheme	Marks
5(a)	$E(T^2) = \int_0^3 \frac{1}{50}(18t^2 - 2t^3) dt + \int_3^5 \frac{1}{20}t^2 dt$	M1
	$= \left[\frac{1}{50} \left(6t^3 - \frac{t^4}{2} \right) \right]_0^3 + \left[\frac{t^3}{60} \right]_3^5$ or $= \left[\frac{3}{25}t^3 - \frac{t^4}{100} \right]_0^3 + \left[\frac{t^3}{60} \right]_3^5$ oe	A1
	$= \frac{1}{50} \left(6 \times 3^3 - \frac{3^4}{2} \right) + \left(\frac{125}{60} - \frac{27}{60} \right)$ or $= \frac{1}{50} \left(162 - \frac{81}{2} \right) + \left(\frac{25}{12} - \frac{9}{20} \right)$ oe	M1d
	$= \frac{1219}{300} = 4.063...$	
	$\text{Var}(T) = "4.063..." - (1.66)^2$	M1
	$= 1.3077...$ awrt 1.31	A1
		(5)
(b)	$\int_3^t \frac{1}{20} dx + C$ where $C = 0.9$ or $\int_0^3 \frac{1}{50}(18 - 2t) dt$ or using $F(5) = 1$ to find C	M1
	$[F(t)] = \begin{cases} 0 & t < 0 \\ \frac{1}{50}(18t - t^2) \text{ or } 1.62 - \frac{(18-2t)^2}{200} & 0 \leq t \leq 3 \\ \frac{1}{20}t + 0.75 & 3 < t \leq 5 \\ 1 & t > 5 \end{cases}$	B1
		A1
		A1
		(4)
(c)	$P(T > 2) = 1 - \frac{1}{50}(18 \times 2 - 2^2)$ or $1 - \int_0^2 \frac{1}{50}(18 - 2t) dt$	M1
	$= \frac{9}{25}$ or 0.36	A1
		(2)
(d)	$P(0 < T < 3.66) = F(3.66)$	M1
	$= 0.933$	A1
		(2)
Notes		Total 13
(a)	M1 Intention to find $E(T^2)$ correctly. They must add the 2 integrals and attempt to integrate (at least one term $x^n \rightarrow x^{n+1}$). Algebraic integration must be seen. Ignore limits. Allow as part of $\text{Var}(T)$ condone $" - (1.66)^2"$ occurring twice. If no algebraic integration shown it is M0	
	A1 Correct integration	
	M1d dep on previous M being awarded for correct limits and attempt to substitute. If no working shown An attempt may be implied by a correct answer or 1219/300 or 243/100 or 49/30 oe	
	M1 For their $E(T^2) - 1.66^2$	
	A1 awrt 1.31 Allow 2452/1875 oe	
(b)	M1 For a correct method to find the 3 rd line including limits unless using $F(5) = 1$ method.	
	B1 2 nd line correct – any letter. Ignore missing inequality	
	A1 3 rd line correct – any letter. Ignore missing inequality	
	A1 Fully correct CDF All in terms of the same letter (Ignore LHS). Allow $<$ instead of $\leq$ and vice versa. Allow "otherwise" for the range on the 1 st or last line but not both.	
(c)	M1 For finding $1 - F(2)$ using their second line or starting again. Must subst in 2	
	A1 cao	
(d)	M1 For realising they need $F(3.66)$ Allow $F(3.66) [- F(0)]$ allow $F("their\ mean + 2") [- F(0)]$	
	A1 Cao allow answer as a fraction	

Question	Scheme	Marks
6. (a)	$\int_0^2 0.1x \, dx + \int_2^4 kx(8-x) \, dx = \frac{31}{45}$	M1
	$\left[\frac{0.1x^2}{2} \right]_0^2 + k \left[4x^2 - \frac{x^3}{3} \right]_2^4 = \frac{31}{45}$	M1
	$0.2 + k \left(64 - \frac{64}{3} - \left(16 - \frac{8}{3} \right) \right) = \frac{31}{45} \rightarrow k = \frac{1}{60}$	dM1 A1
		(4)
(b)(i)	$a = \left[\left(1 - \frac{31}{45} \right) \div 2 \right] \frac{7}{45}$	B1
(ii)	$P(0 \leq X \leq 5.5) = \frac{31}{45} + a \times 1.5 = \frac{83}{90}$	M1 A1
		(3)
(c)	$\int_0^x 0.1t \, dt = \frac{0.1x^2}{2}$	B1
	$\int_0^2 0.1t \, dt + \int_2^x \frac{1}{60} t(8-t) \, dt, \quad \frac{31}{45} + \int_4^x \frac{7}{45} t \, dt$	M1, M1
	$[F(x)] = \begin{cases} 0 & x < 0 \\ 0.05x^2 & 0 \leq x < 2 \\ \frac{1}{60} \left(4x^2 - \frac{x^3}{3} - \frac{4}{3} \right) & 2 \leq x < 4 \\ \frac{7}{45}x + \frac{1}{15} & 4 \leq x < 6 \\ 1 & x \geq 6 \end{cases}$	B1 A1 A1 (6)
Notes		[13 marks]
(a)	1 st M1 sum of two integrals = 31/45 (ignore limits) It may be equated to 31/45 later in their working. Condone missing dx	
	2 nd M1 attempt at integration $x \rightarrow x^2$ or $x^2 \rightarrow x^3$ for at least one	
	3 rd dM1 dep on 1 st M1 being awarded for use of correct limits	
	A1 $k = \frac{1}{60}$ cao Allow 0.016 or equivalent exact value	
	$k = \frac{1}{60}$ with no working gains 4/4 $k = \frac{1}{60}$ from $0.2 = 2k(8-2)$ gains M0M0M0A0	
(b)(i)	B1 $a = \frac{7}{45}$ cao allow 0.15 or equivalent exact value	
(ii)	M1 ft "their value of a" for $\frac{31}{45} + 1.5 \times a$ or $1 - 0.5 \times a$	
	A1 $\frac{83}{90}$ cao Allow 0.92 or equivalent exact value	
(c)	1 st B1 a correct integration of 2nd line of pdf if have + C must get C = 0	
	1 st M1 a correct method to find 3rd line of cdf Condone incorrect integration (allow k)	
	Allow $0.2 + \int_2^x \frac{1}{60} t(8-t) \, dt$ or $\int_2^x \frac{1}{60} t(8-t) \, dt + C$ and $F(2) = 0.2$	
	2 nd M1 a correct method to find 4th line of cdf Condone incorrect integration (allow a)	
	Allow $\int_4^x \frac{7}{45} t \, dt + C$ and $F(6) = 1$ but do not allow their $F(4) + \int_4^x \frac{7}{45} t \, dt$	
	For the next 3 marks limits condone < for , and , for < and ...for >	
	2 nd B1 1 st and 5 th lines correct with correct limits. Allow 1 range to be otherwise for the limits, Must have consistent use of letter throughout for this mark	
	1 st A1 3 rd line correct with correct limits Allow equivalent un-simplified expressions	
	2 nd A1 4 th line correct with correct limits Allow equivalent un-simplified expressions	

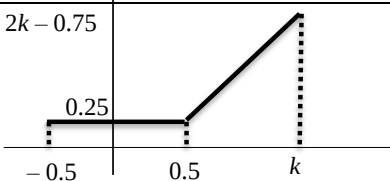
Question Number	Scheme	Marks
5. (a)	$F(3) = 0 \rightarrow \frac{1}{16}(3^2 - 6(3) + a) = 0$ $a = 9$ $F(10) = 1 \rightarrow \frac{1}{12}(100(10) - (5)10^2 + c) = 1$ $c = -488$	M1 A1 M1 A1 (4)
(b)	$\frac{1}{16}(5^2 - 6(5) + "9") = \frac{1}{12}(5 + b) \quad \left \quad \frac{1}{12}(9 + b) = \frac{1}{12}(100(9) - 5(9^2) + "-488") \right.$ $b = -2$	M1 A1 (2)
(c)	$P(6 < Y \leq 9) = F(9) - F(6)$ $= \frac{1}{12}(9 + "-2") - \frac{1}{12}(6 + "-2")$ $= \frac{1}{4}$	M1 M1 A1 (3)
(d)	$f(y) = \frac{1}{12}$	B1 (1)
(e)	$E(6Y - 5) = [26.5 +] \int_5^9 (6y - 5) " \frac{1}{12} " dy$ $= [26.5 +] \frac{1}{12} [(3y^2 - 5y)]_5^9$ $= 26.5 + \frac{1}{12} [(3(9^2) - 5(9)) - (3(5^2) - 5(5))]$ $= \frac{233}{6}$	M1 dM1 dM1 A1 (4)
[Total 14]		
Notes		
(a)	1 st M1 writing or use of $F(3) = 0$ 1 st A1 $a = 9$ cao 2 nd M1 writing or use of $F(10) = 1$ 2 nd A1 $c = -488$ cao	
(b)	M1 use of $F(5) = F(5) [= \frac{1}{4}]$ or $F(9) = F(9) [= \frac{7}{12}]$ ft their values from (a) A1 $b = -2$ cao	
(c)	1 st M1 writing or using $F(9) - F(6)$ (may be implied by 2 nd M1) 2 nd M1 substituting 9 and 6 into $F(x)$ with their value of b allow $\frac{1}{12}(100(9) + 5(9^2) + "-488") - \frac{1}{12}(6 + "-2")$ with their value of b and their value of c A1 $\frac{1}{4}$ oe	
(d)	B1 $\frac{1}{12}$	
(e)	1 st M1 use of $\int_5^9 (6y - 5) " \frac{1}{12} " dy$ (ignore limits) 2 nd M1 (dep on 1 st M1) attempt to integrate $(6y - 5) " \frac{1}{12} "$ with at least one $y^n \rightarrow y^{n+1}$ 3 rd M1 (dep on 1 st M1) $26.5 + \int_5^9 (6y - 5) " \frac{1}{12} " dy$ A1 awrt 38.8	
SC:	Answer only or correct answer not using given information scores M0M1M1A1	

Question Number	Scheme	Marks
3. (a)		M1 A1 (2)
(b)	$\frac{d\left(\frac{3}{50}(4y^2 - y^3)\right)}{dy} = \frac{3}{50}(8y - 3y^2)$ $\frac{3}{50}(8y - 3y^2) = 0 \quad ; \quad y = \frac{8}{3} \text{ oe}$	M1 M1; A1 (3)
(c)	$E(Y^2) = \int_1^2 \left(\frac{6}{25}y^3 - \frac{6}{25}y^2 \right) dy + \int_2^4 \left(\frac{12}{50}y^4 - \frac{3}{50}y^5 \right) dy$ $= \left[\frac{6}{100}y^4 - \frac{6}{75}y^3 \right]_1^2 + \left[\frac{12}{250}y^5 - \frac{3}{300}y^6 \right]_2^4$ $= \left[\left(\frac{8}{25} \right) - \left(-\frac{1}{50} \right) \right] + \left[\left(\frac{1024}{125} \right) - \left(\frac{112}{125} \right) \right] ; \quad = \frac{1909}{250} \text{ or } \underline{7.636} \text{ or } \underline{7.64}$	M1 A1 dM1; A1 (4)
(d)	$\text{Var}(Y) = \frac{1909}{250} - 2.696^2$ $= 0.367584 \quad \text{awrt } \underline{0.368}$	M1 A1 (2)
(e)	$\frac{1}{2}(y-1) \times \frac{6}{25}(y-1) = 0.1 \quad \text{or} \quad \int_1^x \frac{6}{25}(y-1) dy = 0.1$ $\frac{1}{2}(y-1) \times \frac{6}{25}(y-1) = 0.1 \quad \text{or} \quad \frac{6}{25} \left[\left(\frac{x^2}{2} - x \right) + \frac{1}{2} \right] = 0.1 \quad \text{or} \quad \frac{6}{50}(x-1)^2 = 0.1$ $(y-1)^2 = \frac{5}{6} \quad \text{or} \quad y = 1 \pm \sqrt{\frac{5}{6}} ; \quad y = 1.9128... \quad \text{awrt } \underline{1.91}$	M1 A1 dM1; A1 (4)
Total 15		
Notes		
(a)	M1: the two parts must be the right shape and not joined. Ignore labels and condone if it goes below x - axis A1: for 6/25, 12/25, 1, 2 and 4 and must not go beyond 4 or < 1 [Can allow “freehand” straight line]	
(b)	1st M1: for attempting to differentiate $y^n \rightarrow y^{n-1}$ for $n = 2$ or 3 2nd M1: for equating their differential ($\neq f(y)$) to zero and an attempt at solving so must reach $y = \dots$ A1: for $\frac{8}{3}$ oe and allow awrt 2.67 If $y = 0$ is seen it must be rejected.	
(c)	1st M1: for using $\int y^2 f(y)$ for both parts, <u>and</u> an attempt at integration (some $y^n \rightarrow y^{n+1}$) Ignore limits. 1st A1: for correct integration for both parts. Ignore limits. 2nd dM1 : dep on 1 st M1 for adding the 2 parts together <u>and</u> substituting the correct limits in to each part. 2nd A1: allow 7.64 or 7.636 You will need to check that they have used algebraic integration.	
(d)	M1: for “their part(c)” – 2.696 ² A1: for awrt 0.368	
(e)	1st M1: allow $\frac{1}{2}t \times \frac{6}{25}(t-1) = 0.1$ or $\int_1^x \frac{6}{25}(y-1) dy = 0.1$ <u>and</u> some integration and sub’ of 1 and x 1st A1: for a correct equation in any form 2nd dM1: dependent on 1 st M1 for a correct method for solving their equation. Implied by correct answer. 2nd A1: for awrt 1.91 (second solution should be rejected)	

Question Number	Scheme	Marks
4 (a)		B1 B1
		(2)
(b)	$\frac{1}{2}(3+9) \times k = 1 \quad \text{or} \quad \frac{1}{2}(3-1)k + (6-3)k + \frac{1}{2}(10-6)k = 1$ $\text{or} \quad \frac{1}{2}k \left[\frac{x^2}{2} - x \right]_1^3 + k[x]_3^6 + \frac{1}{4}k \left[10x - \frac{x^2}{2} \right]_6^{10} = 1$ $k = \frac{1}{6} *$	M1 A1* cso
		(2)
(c)	$\int_1^x \frac{1}{12}(x-1) dx \quad \text{or} \quad \int \frac{1}{12}(x-1) dx \quad \text{and using } F(1) = 0$ $\int_3^x \frac{1}{6} dx + "F(3)" \quad \text{or} \quad \int \frac{1}{6} dx \quad \text{and using } "F(3) = \frac{1}{6}"$ $\int_6^x \left(\frac{5}{12} - \frac{1}{24}x \right) dx + "F(6)" \quad \text{or} \quad \int \left(\frac{5}{12} - \frac{1}{24}x \right) dx \quad \text{and using either } "F(6) = \frac{2}{3}" \text{ or } F(10) = 1$ $F(x) = \begin{cases} 0 & x < 1 \\ \frac{1}{24}(x^2 - 2x + 1) & 1 \leq x \leq 3 \\ \frac{1}{6}(x - 2) & 3 < x \leq 6 \\ \frac{1}{48}(20x - x^2 - 52) \quad \text{or} \quad 1 - \frac{(10-x)^2}{48} & 6 < x \leq 10 \\ 1 & x > 10 \end{cases}$	M1 M1 M1 A1oe A1oe A1 oe B1
		(7)
(d)	$P(X > E(X)) = 1 - F\left(\frac{61}{12}\right) = 1 - 0.51388... = 0.4861... \quad \text{awrt } 0.486$	M1 A1 (2)
(e)	Since (d) < 0.5 [the mean is greater than the median] therefore positive (skew) or follow through their sketch in part (a)	M1 A1ft
		(2)
Notes		Total 15
4(a)	B1	Correct shape. Must start and end on the x axis
	B1	Fully correct including 1, 3, 6, 10 and k. Allow $\frac{1}{6}$ for k Ignore labels for x and f(x) and any extras e.g. $\frac{k}{2}$
(b)	M1	Setting up the area of the trapezium = 1 or 2 triangles + a rectangle = 1 or a fully correct integration, including limits = 1
	A1* cso	Answer is given. Correct solution only with no incorrect working.
(c)	M1	For a correct method to find the 2 nd line Allow in terms of k

	M1	For a correct method to find the 3 rd line, ft their $F(3)$. If using + c method then ft their $F(3) = \frac{1}{6}$ Allow in terms of k
	M1	For a correct method to find the 4 th line, ft their $F(6)$. If using + c method then ft their $F(6) = \frac{2}{3}$ Allow in terms of k
	A1	2 nd line correct including inequality. Allow < instead of $\leq$
	A1	3 rd line correct including inequality. Allow < instead of $\leq$
	A1	4 th line correct including inequality. Allow < instead of $\leq$
	B1	1 st and 5 th line correct. Allow “otherwise” for the range on the 1 st or 5 th line but not both. All 5 lines must be in terms of the same letter.
(d)	M1	For use of $1 - F\left(\frac{61}{12}\right)$ using the their line of $F(x)$ for $3 < x \leq 6$. May use integration/area methods
	A1	awrt 0.486 Allow $^{35}/_{72}$
(e)	M1	For correctly comparing part (d) with 0.5 (may be implied by a correct comparison of mean and median (5)) do not allow mean is greater than the median on its own
	A1ft	For positive skew or ft their answer to part (d) Accept “no (or negligible) skew” following a reason that “mean $\approx$ median” Allow argument based on sketch in part (a)



Question Number	Scheme		Marks
2 (a)			M1 A1
			(2)
(b)	Area = $\frac{1}{4} + \frac{1}{2}\left(\frac{1}{4} + 2k - \frac{3}{4}\right)\left(k - \frac{1}{2}\right) = 1$ or $\frac{1}{4}\left(k + \frac{1}{2}\right) + \frac{1}{2}(2k - 1)\left(k - \frac{1}{2}\right) = 1$ or $\frac{1}{4} + \left[\left(k^2 - \frac{3}{4}k\right) - \left(\frac{1^2}{2} - \frac{3}{8}\right)\right] = 1$		M1
	$8k^2 - 6k - 5 = 0$ or $k^2 - \frac{3}{4}k - \frac{5}{8} = 0$ oe		A1
	$(4k - 5)(2k + 1) = 0$ or $k = \frac{\frac{3}{4} \pm \sqrt{\left(-\frac{3}{4}\right)^2 + 4 \times \left(\frac{5}{8}\right)}}{2}$ oe		M1
	$k = 1.25^*$		A1 *
			(4)
(c)	$\left[\int_{-0.5}^{0.5} \frac{1}{4}x \, dx\right] + \int_{0.5}^{1.25} 2x^2 - \frac{3}{4}x \, dx = [0] + \left[\frac{2x^3}{3} - \frac{3}{8}x^2\right]_{0.5}^{1.25}$		M1A1
	$= \left(\frac{2 \times 1.25^3}{3} - \frac{3}{8} \times 1.25^2\right) - \left(\frac{2 \times 0.5^3}{3} - \frac{3}{8} \times 0.5^2\right)$		dM1
	$= \frac{93}{128}$ awrt 0.727		A1
			(4)
(d)	$[Q_1] = 0.5$		B1
	$Q_3^2 - \frac{3}{4}Q_3 + 0.125 = 0.5$ or $Q_3^2 - \frac{3}{4}Q_3 - 0.375 = 0$ oe		M1
	$Q_3 = \frac{\frac{3}{4} \pm \sqrt{\left(-\frac{3}{4}\right)^2 + 4 \times \left(\frac{1}{8}\right)}}{2}$		M1
	$\text{IQR} = "1.093..." - 0.5$		M1
	$= 0.593...$ awrt 0.59		A1
			(5)
Notes			Total 15
(a)	M1	A correct shape. Must not go below zero	
	A1	A correct shape including labels. Allow 1.25 for k and 1.75 for $2k - 0.75$	
(b)	M1	Equating area to 1 (0.75 if $\frac{1}{4} +$ is not present) A correct method to find the area - allow 1 sign error. May be implied by a correct 3 term quadratic. If using integration then must get to an equivalent equation as the main scheme	
	A1	For a correct 3 term quadratic	
	M1	A correct method to solve a 3 term quadratic (May be implied by 1.25 and -0.5) If the 3 term quadratic is incorrect then a correct method for solving their 3 term quadratic must be shown	
	A1*	1.25 must be the only answer given. All previous marks must be awarded.	
(c)	M1	$\int_{-0.5}^{0.5} \frac{1}{4}x \, dx + \int_{0.5}^{1.25} 2x^2 - \frac{3}{4}x \, dx$ or $\int_{0.5}^{1.25} 2x^2 - \frac{3}{4}x \, dx$ on its own	

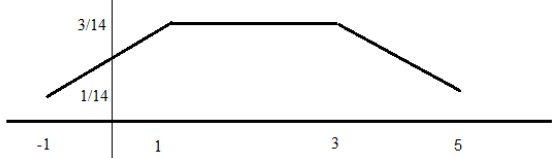
	A1	Correct integration of $2x^2 - \frac{3}{4}x$
	dM1	Dep on previous M being awarded. Substituting in the correct limits (implied by $\frac{93}{128}$ or awrt 0.727 Condone 0.726) If the integration is incorrect, we must see the correct non simplified substitution into their integral. Ignore substitution into $\frac{1}{8}x^2$. Useful values to look for are $\frac{125}{96}$, $\frac{75}{128}$, $\frac{1}{12}$ and $\frac{3}{32}$ or $\frac{275}{384}$ and $\pm \frac{1}{96}$
	A1	For $\frac{93}{128}$ or awrt 0.727
(d)	B1	For 0.5 May be seen in their IQR
	M1	A correct equation for finding Q_3
	M1	A correct method to solve a 3 term quadratic (implied by $Q_3 = \frac{3+\sqrt{33}}{8}$ or $\frac{3-\sqrt{33}}{8}$ or awrt 1.093 or awrt -0.343) If the 3 term quadratic is incorrect then a correct method for solving their 3 term quadratic must be shown. If using $Q_3^2 - \frac{3}{4}Q_3 - \frac{5}{8} = 0$ then M0
	M1	Correct method to find the IQR ft their Q_3 or implied by awrt 0.593
	A1	awrt 0.59 Allow $\frac{-1+\sqrt{33}}{8}$

Question Number	Scheme		Marks
7 (a)	$\frac{1}{2} \times 8 \times 4a = 1 \Rightarrow a = \frac{1}{16} *$ or $\int_{[0]}^{[4]} ax \, dx = 0.5 \Rightarrow \left[\frac{ax^2}{2} \right]_0^4 = 0.5 \Rightarrow a = \frac{1}{16} *$		B1*
			(1)
(b) (i)	(By symmetry) $b = -\frac{1}{16}$		B1
(ii)	At (8, 0) $0 = -\frac{1}{16} \times 8 + c \Rightarrow c = \frac{1}{2}$ or at (4, 0.25) $0.25 = -\frac{1}{16} \times 4 + c \Rightarrow c = \frac{1}{2}$		M1 A1
			(3)
(c)	$E(X) = 4$		B1
	$E(X^2) = \int_0^4 x^2 \left(\frac{1}{16} x \right) dx + \int_4^8 x^2 \left(-\frac{1}{16} x + \frac{1}{2} \right) dx$		M1
	$= \frac{1}{64} [x^4]_0^4 + \left[-\frac{1}{64} x^4 + \frac{1}{6} x^3 \right]_4^8$		A1ft
	$= 4 + \left[\left(-64 + \frac{256}{3} \right) - \left(-4 + \frac{32}{3} \right) \right] \left[= \frac{56}{3} \right]$		dM1A1
	$\text{Var}(X) = \frac{56}{3} - 4^2 = \frac{8}{3} *$		A1*
			(6)
(d)	$\frac{1}{2} \times Q_1 \times \frac{1}{16} \times Q_1 = \frac{1}{4}$ or $\int_0^{Q_1} \frac{1}{16} x \, dx = 0.25 \rightarrow \frac{Q_1^2}{32} = 0.25$		M1
	$Q_1 = \sqrt{8} = 2.828...$ or $Q_3 = 8 - \sqrt{8} = 5.171...$ awrt 2.83 or awrt 5.17		A1
	$Q_1 = \sqrt{8} = 2.828...$ and $Q_3 = 8 - \sqrt{8} = 5.171...$ awrt 2.83 and awrt 5.17		A1
			(3)
(e)	50% lies between Q_1 and Q_3		
	Statistician's claim: $P\left(4 - \sqrt{\frac{8}{3}} < X < 4 + \sqrt{\frac{8}{3}}\right) = P(2.37 < X < 5.63)$		M1
	as this is outside Q_1 and Q_3 , > 0.5 / statistician's claim is correct* or $P(2.37 < X < 5.63) = 0.6498... > 0.5$ / statistician's claim is correct*		A1*
			(2)
Notes			Total 15
(a)	B1*	Allow any correct equivalent method. E.g. $\frac{1}{2} \times 4 \times 4a = \frac{1}{2} \Rightarrow a = \frac{1}{16}$, integration, use of gradients, etc. Answer is given so a complete correct method with no incorrect working must be seen	
(b)	B1	Cao	
	M1	Use of equation of line to find c e.g. $y - 0 = -\frac{1}{16}(x - 8)$ or use of integration or any valid method	
	A1	Cao correct answer scores M1A1	

(c)	B1	For $E(X) = 4$ This may be seen at any point in the solution
	M1	For use of $\int x^2 f(x) dx \quad x^n \rightarrow x^{n+1}$ for both parts of pdf (ignore limits) ft their values of b and c
	A1ft	For correct integration of either of the 2 parts, ft their values of b and c
	depM1	For use of correct limits in either part (dep on previous M1) may be implied by sight of 4 or $\frac{44}{3}$ but not implied by $\frac{56}{3}$ allow ft on their values of b and c which you may need to check
	A1	For complete correct substitution $4 + \left[\left(-64 + \frac{256}{3} \right) - \left(-4 + \frac{32}{3} \right) \right]$ or $\frac{56}{3}$ allow $= 4 + \frac{44}{3}$
	A1*	Answer is given so need to see use of $\text{Var}(X) = E(X^2) - E(X)^2 = \frac{8}{3}$ with values substituted
(d)	M1	For correct method for either Q_1 or Q_3 e.g. $\frac{1}{2} \times Q_1 \times \frac{1}{16} \times Q_1 = \frac{1}{4}$, $\int_0^{Q_1} \frac{1}{16} x dx = 0.25 \rightarrow \frac{Q_1^2}{32} = 0.25$
	A1	For either awrt 2.83 allow $\sqrt{8}$ oe or awrt 5.17 allow $8 - \sqrt{8}$ oe
	A1	For either awrt 2.83 allow $\sqrt{8}$ oe and awrt 5.17 allow $8 - \sqrt{8}$ oe
(e)	M1	For use of $P(\mu - \sigma < X < \mu + \sigma)$ ft their μ implied by awrt 2.37 and awrt 5.63
	A1*	Must state that this > 0.5 as it is outside Q_1 and Q_3 Allow '2.83' $>$ '2.37' and '5.16' $<$ '5.63' or a correct probability calculated awrt 0.65 Answer is given so no incorrect working can be seen. If their values are not consistent with the statistician's claim, then A0 here.

Question	Scheme	Marks
6(a)	$\int_{-1}^3 (a+bx) dx [=1]$ <u>or</u> trapezium drawn	M1
	$\left[ax + \frac{bx^2}{2} \right]_{-1}^3 [=1]$ oe <u>or</u> $\frac{3-(-1)}{2}((a-b)+(a+3b)) [=1]$	A1
	$\left[3a + \frac{9b}{2} \right] - \left[-a + \frac{b}{2} \right] = 1$ oe <u>or</u> $\frac{4}{2}(2a+2b) = 1 \Rightarrow 4a+4b=1^*$	A1*
		(3)
(b)(i)	$\int_{-1}^3 ax^2 + bx^3 dx = \left[\frac{ax^3}{3} + \frac{bx^4}{4} \right]_{-1}^3$	M1A1
	$\left[\frac{27a}{3} + \frac{81b}{4} \right] - \left[-\frac{a}{3} + \frac{b}{4} \right] = \frac{17}{5}$	dM1
	$\frac{28}{3}a + 20\left(\frac{1-4a}{4}\right) = \frac{17}{5}$	M1 A1
		(5)
(ii)	$-\frac{32}{3}a = -\frac{8}{5}$ oe <u>or</u> $\frac{28}{3}\left(\frac{1-4b}{4}\right) + 20b = \frac{17}{5}$	M1
	$b = \frac{1-4 \times 0.15}{4} \Rightarrow b = 0.1^*$	A1*
		(2)
(c)		M1 A1
		(2)
(d)	$\left["0.15" k + \frac{0.1k^2}{2} \right] - \left[-"0.15" + \frac{0.1}{2} \right] = 0.2$ <u>or</u> $\frac{1}{2}(k+1)(0.05+0.1k+0.15) = 0.2$	M1
	$\left[0.45 + \frac{0.9}{2} \right] - \left["0.15" k + \frac{0.1k^2}{2} \right] = 0.8$ <u>or</u> $\frac{1}{2}(3-k)(0.15+0.1k+0.45) = 0.8$	M1
	$0.05k^2 + 0.15k - 0.1 = 0$	A1
	$k = \frac{-0.15 \pm \sqrt{0.15^2 - 4 \times 0.05 \times (-0.1)}}{2 \times 0.05}$	M1
	$= 0.56155...$ awrt 0.562	A1
		(4)
		Total 16

	Notes	
(a)	M1	for an attempt to integrate $a + bx$ with either $a \rightarrow ax$ or $x \rightarrow x^2$ ignore limits or for trapezium drawn with parallel sides correct in terms of a and b (may be implied by correct area of trapezium)
	A1	correct integration or correct area of trapezium
	A1*	cso (correct limits seen substituted or correct area) equated to 1 which leads to final given answer
	Mark b(i) and b(ii) together	
(b)(i)	M1	for an attempt to integrate $ax^2 + bx^3$ with either $x^2 \rightarrow x^3$ or $x^3 \rightarrow x^4$ ignore limits
	A1	correct integration ignore limits
	dM1	dep on previous M1. Substituting in correct limits and equating to 17/5
	M1	substituting $4b = 1 - 4a$ oe
	A1	a correct equation
(ii)	M1	solving their equation in a in the form $na = c$ where $n \neq 1$ or a correct equation in terms of b M0 for $a = 0.15$ without working or for using $b = 0.1$ in $4a + 4b = 1$ to find a
	A1*	for a correct un-simplified expression for b leading to given answer $b = 0.1$ * which must come from correct working
(c)	M1	correct shape (straight line with positive gradient) must be above x-axis and must be between -1 and 3 ignore graph before -1 and after 3
	A1	correct with both correct x-axis labels -1 and 3 and at least 1 correct y-axis label from 0.05 , 0.15 or 0.45 ignore graph before -1 and after 3
(d)	M1	for a correct equation using integration or area need not be simplified. use of limit $k + 1$ instead of k in integration is M0
	A1	correct 3 term quadratic (oe)
	M1	correct method seen to solve their 3 term quadratic or awrt 0.562 or awrt -3.56
	A1	awrt 0.562 with other solutions eliminated if given Allow $\frac{\sqrt{17} - 3}{2}$

Qu'n Number	Scheme	Marks
6(a)		B1 B1
		(2)
(b)	$E(Y) = 2$	B1
	$\text{Var}(2Y - 3) = 4\text{Var}(Y)$	M1
	$\text{Var}(Y) = \left(\frac{131}{21} - 2^2 \right)$	M1
	$\text{Var}(2Y - 3) = \frac{188}{21}$ awrt 8.95	A1
		(4)
(c)	$\int_{-1}^t \frac{1}{14}(y+2)dy = \frac{1}{14} \left[\frac{y^2}{2} + 2y \right]_{-1}^t$ or $\int_{-1}^t \frac{1}{14}(y+2)dy = \frac{1}{14} \left[\frac{y^2}{2} + 2y \right] + C$ or $\int \frac{1}{14}(y+2)dy = \frac{1}{28}(y+2)^2 + C$	M1
	$\frac{1}{14} \left[\left(\frac{t^2}{2} + 2t \right) - \left(\frac{1}{2} - 2 \right) \right]$ or $\frac{1}{14} \left[\frac{(-1)^2}{2} - 2 \right] + C = 0$ & $C = \frac{3}{28}$ or $\frac{1}{28}(-1+2)^2 + C = 0$ & $C = -\frac{1}{28}$ leading to $\frac{1}{14} \left(\frac{y^2}{2} + 2y + \frac{3}{2} \right)^*$	A1*cs0
		(2)
(d)	$\int_1^t \frac{3}{14}dy + F(1) = \left[\frac{3}{14}y \right]_1^t + F(1) = \left[\left(\frac{3t}{14} \right) - \left(\frac{3}{14} \right) \right] + F(1)$ or $\int \frac{3}{14}dy = \left[\frac{3}{14}y \right] + C$ and use of $F(1) = \text{"their } F(1)\text{"}$ or $F(3) = \text{"their } F(3)\text{"}$	M1
	$\int_3^t \frac{1}{14}(6-y)dy + F(3) = \frac{1}{14} \left[6y - \frac{y^2}{2} \right]_3^t + F(3) = \frac{1}{14} \left[\left(6t - \frac{t^2}{2} \right) - \left(18 - \frac{9}{2} \right) \right] + F(3)$ or $\int \frac{1}{14}(6-y)dx = \frac{1}{14} \left[6y - \frac{y^2}{2} \right] + C$ or $C - \frac{(6-y)^2}{28}$ and use $F(5) = 1$	M1
	$F(y) = \begin{cases} 0 & y_n - 1 \\ \frac{1}{14} \left(\frac{y^2}{2} + 2y + \frac{3}{2} \right) & -1 < y_n - 1 \\ \frac{3}{14}y + \frac{1}{14} & 1 < y_n - 3 \\ \frac{3}{7}y - \frac{1}{28}y^2 - \frac{1}{4} & 3 < y_n - 5 \text{ \& } \\ 1 & y > 5 \end{cases}$	A1 A1 B1
		(5)

(e)	$\frac{3}{14}m + \frac{1}{14} = 0.3$	M1
	$m = \frac{16}{15}$	A1
		(2)
(f)	$P(4Y \leq 5 \mid Y \leq 3) = \frac{\left(\frac{3}{14} \times \frac{5}{4} + \frac{1}{14}\right)}{\left(\frac{3}{14} \times 3 + \frac{1}{14}\right)} \left[\frac{19/56}{5/7} \right]$	M1
	$= \frac{19}{40} \text{ or } 0.475$	A1
		(2)
		Total 17

		Notes
(a)	B1	Shape correct – must not touch/cross the x -axis
	B1	Fully correct including labels (all x -axis and at least one vertical axis label which may be $2/14$)
(b)	B1	Correct value for $E(Y)$
	M1	Writing or using $4 \text{ Var } (Y)$ on its own
	M1	Correct formula for $\text{Var } (Y)$ allow use of their $E(Y)$ if clearly stated
	A1	awrt 8.95
(c)	M1	For a correct method for $-1 < y, 1$ Allow finding the area: attempt at trapezium $\times (y+1)$ $\frac{1}{2} \left(\frac{1}{14} + \frac{1}{14}(y+2) \right) (y+1)$
	A1*cao	A fully correct solution with substitution seen or C found leading to $\frac{1}{14} \left(\frac{y^2}{2} + 2y + \frac{3}{2} \right)$
		Allow any letter
(d)	M1	For a correct method for $1 < y, 3$ Allow finding the area $\left(\frac{1}{14} + \frac{3}{14} \right) + \frac{3}{14}(y-1)$ or $F(1) + \frac{3}{14}(y-1)$
	M1	For a correct method for $3 < y, 5$ Allow finding the area $\left(\frac{1}{14} + \frac{3}{14} \right) + \frac{6}{14} + \frac{1}{2} \left(\frac{3}{14} + \frac{1}{14}(6-y) \right) (y-3)$ or $F(3) + \frac{1}{2} \left(\frac{3}{14} + \frac{1}{14}(6-y) \right) (y-3)$
	A1	For a correct expression attached to $1 < y, 3$
	A1	For a correct expression attached to $3 < y, 5$ Allow $\frac{29 - (6-y)^2}{28}$ oe
(e)	B1	Top, 2 nd and bottom line correct plus all in terms of the same letter. Allow $<$ for $,$ and vice versa
	M1	Setting their equation for $1 < y, 3$ equal to 0.3
	A1	cao
(f)	M1	For writing or using $\frac{F(\frac{5}{4})}{F(3)}$ Allow use of their expression for $3 < y, 5$ for the denominator
	A1	cao

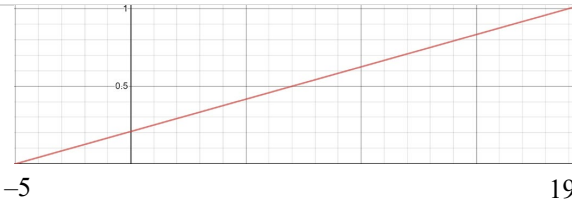
Question Number	Scheme	Marks
6 (a)	$[F(k) = 1 \Rightarrow] ak + bk^2 = 1 \Rightarrow ak = 1 - bk^2 *$	B1*
		(1)
(b)	$f(x) = a + 2bx$	B1
	$E(X) = \int_0^k (ax + 2bx^2) dx \left[= \frac{6}{5} \right] \Rightarrow \left[\frac{ax^2}{2} + \frac{2bx^3}{3} \right]_0^k \left[= \frac{6}{5} \right]$	M1
	$\frac{ak^2}{2} + \frac{2bk^3}{3} = \frac{6}{5}$	dM1, A1
	$15ak^2 + 20bk^3 = 36$	
	$15k(1 - bk^2) + 20bk^3 = 36$	M1
	$5bk^3 = 36 - 15k *$	A1*
		(6)
(c)	$E(X^2) = \int_0^k (ax^2 + 2bx^3) dx \Rightarrow \left[\frac{ax^3}{3} + \frac{bx^4}{2} \right]_0^k$	M1
	$\text{Var}(X) = \frac{ak^3}{3} + \frac{bk^4}{2} - \frac{36}{25} = \frac{22}{75}$	dM1 A1
	$10ak^3 + 15bk^4 = 52$	
	$10k^2(1 - bk^2) + 15bk^4 = 52$	M1
	$5bk^4 = 52 - 10k^2 *$	A1*
		(5)
(d)	$\frac{1}{k} = \frac{36 - 15k}{52 - 10k^2}$	M1
	$5k^2 - 36k + 52 = 0$	A1
	$(k - 2)(5k - 26) = 0$	M1
	$k = 2$	A1
		(4)
(e)	'40'b = $36 - '30' \Rightarrow b = \frac{3}{20}$ or '80'b = $52 - '40' \Rightarrow b = \frac{3}{20}$	B1ft
	$2a + \frac{3}{5} = 1 \Rightarrow a = \frac{1}{5}$	B1ft
		(2)
Notes		Total 18
(a)	B1*	Answer is given so no incorrect working can be seen
(b)	B1	For a correct expression for f(x) (may be implied by a correct expression for E(X))
	M1	For an attempt to integrate x f(x) (Ignore limits) at least one ($x^n \rightarrow x^{n+1}$). F.t. their f(x) f(x) must be a changed expression from F(x) so integrating xF(x) is M0
	dM1	Dependent on the previous M mark. For equating to $\frac{6}{5}$ and substitution of k (no need to see substitution of lower limit 0).
	A1	For a correct equation any form
	M1	For substitution of $ak = 1 - bk^2$ oe into their equation
	A1*	Answer is given so no incorrect working can be seen

(c)	M1	For an attempt to integrate $x^2 f(x)$ (Ignore limits) at least one $(x^n \rightarrow x^{n+1})$ F.t. their $f(x)$ $x^2 F(x)$ is M0
	dM1	Dependent on previous M mark. For substitution of correct limits and subtraction of $\frac{36}{25} = \frac{22}{75}$
	A1	For a correct equation any form
	M1	For substitution of $ak = 1 - bk^2$ oe into their equation
	A1*	Answer is given so no incorrect working can be seen
(d)	M1	For solving simultaneously to set up an equation in k only
	A1	For a correct 3 term quadratic
	M1	For solving their 3 term quadratic by factorising, completing the square or using formula. $k = 5.2$ implies M1A1M1
	A1	2 only cao. Correct answer on its own scores 4 out of 4
(e)	B1ft	For $b = \frac{3}{20}$ ft their k $b = \frac{36-15k}{5k^3}$ Common ft answer is $b = \frac{-525}{8788} = \text{awrt } -0.0597$ coming from choosing $k = 5.2$
	B1ft	For $a = \frac{1}{5}$ ft their k and their b $a = \frac{1-bk^2}{k}$ Common ft answer is $a = \frac{85}{169} = \text{awrt } 0.503$ coming from choosing $k = 5.2$

Question Number	Scheme		Marks
7 (a)	$P(L \geq 4.5) \Rightarrow P(A \geq 20.25)$		
	$P(A \geq 20.25) = (30 - 20.25) \times \frac{1}{20}$		M1
	$= 0.4875$		A1
			(2)
(b)	$\text{Var}(L) = E(L^2) - E(L)^2$		
	$[E(L^2) = E(A)] = 20$		B1
		$g(L) = \begin{cases} \frac{L}{10} & \sqrt{10} \leq L \leq \sqrt{30} \\ 0 & \text{otherwise} \end{cases}$	
	$E(L) = E(\sqrt{A}) = \frac{1}{20} \int_{10}^{30} \sqrt{a} \, dA$	$E(L) = \frac{1}{10} \int_{\sqrt{10}}^{\sqrt{30}} L^2 \, dL$	M1
	$= \frac{1}{20} \left[\frac{2}{3} a^{\frac{3}{2}} \right]_{10}^{30}$	$\frac{1}{10} \left[\frac{L^3}{3} \right]_{\sqrt{10}}^{\sqrt{30}}$	A1
	$= 4.4231\dots$		A1
	$\text{Var}(L) = "20" - ("4.4231\dots")^2$		M1
	$= 0.4358\dots$		awrt 0.436 A1 (6)
	Notes		Total 8
7 (a)	M1	$(30 - 20.25) \times \frac{1}{20}$	
	A1	cao (Allow 0.488 or $\frac{39}{80}$)	
(b)	B1	For 20	
	M1	Attempt to integrate $\frac{1}{20} \int_{10}^{30} \sqrt{a} \, dA$ or $\frac{1}{10} \int_{\sqrt{10}}^{\sqrt{30}} L^2 \, dL$ Ignore limits and accept any letter	
	A1	Fully correct integration. Accept any letter. Must have limits	
	A1	4.42 or better	
	M1	Use of $\text{Var}(L) = E(L^2) - E(L)^2$ ft their $E(L^2)$ and $E(L)$ provided $\text{Var}(L) > 0$	
	A1	awrt 0.436	

Question Number	Scheme		Marks
3 (a)(i) (ii)	3 + [0] + 29 = 32*		B1*
	3 + 15 + 29 = 47*		B1*
			(2)
(b)	$f(t) = \begin{cases} \frac{1}{15} & 32 \leq t \leq 47 \\ 0 & \text{otherwise} \end{cases}$		M1 A1
			(2)
(c) (i)	[E(T) =] 39.5 oe		B1
(ii)	$[\text{Var}(T) =] \frac{(47 - 32)^2}{12}$		M1
	$\frac{75}{4} = 18.75$		A1
			(3)
(d)	$(40 - 32) \times \frac{1}{15}$		M1
	$= \frac{8}{15}$		A1
			(2)
	Notes		Total 9
(a)(i)	B1*	For 3 + [0] + 29	
(ii)	B1*	For 3 + 15 + 29 Allow 32 + 15	
(b)	M1	For $f(t) = \frac{1}{15} \quad 32 \leq t \leq 47$ Allow use of < instead of one/both $\leq$ signs. Allow the use of any letter for f(t) and t (Condone inconsistent use of letters) but we must have f(t) and an inequality	
	A1	Fully correct pdf $f(t) = \begin{cases} \frac{1}{15} & 32 \leq t \leq 42 \\ 0 & \text{otherwise} \end{cases}$ Must be f(t) and t. Condone f(T) and T Allow use of < instead of one/both $\leq$ signs Allow equivalent for the 0 otherwise.	
(c)(i)	B1	For 39.5 oe	
(ii)	M1	For use of $\text{Var}(T) = \frac{(\beta - \alpha)^2}{12}$	
	A1	For 18.75 oe	
(d)	M1	For use of $(40 - \alpha) \times \frac{1}{\beta - \alpha}$	
	A1	For $\frac{8}{15}$ oe Allow awrt 0.533	

Question Number	Scheme			Marks
4 (i)(a)	$\frac{b-27}{b-a} = \frac{3}{4}$ or $\frac{27-a}{b-a} = \frac{1}{4}$ and $\frac{(b-a)^2}{12} = 300$			M1M1
	$a = 12$ and $b = 72$			A1
				(3)
(b)	$\left[4P(X < k-10) = P(X > k+20) \Rightarrow \right] 4\left(\frac{k-10-'12'}{72-12'}\right) = \frac{72'-(k+20)}{72-12'}$			M1
	$4(k-22) = 52-k \Rightarrow k = 28$			A1
				(2)
(ii)	$L \square U(21, 42)$	$L \square U(0, 42)$	$S \square U(5.25, 10.5)$	
	$\frac{L}{4} - \left(\frac{42-L}{4}\right) > 2$	$\frac{L}{4} - \left(\frac{42-L}{4}\right) > 2$ or $\left(\frac{42-L}{4}\right) - \frac{L}{4} > 2$	$S - (10.5-S) > 2$	M1
	$L > 25$	$L < 17$ or $L > 25$	$S > 6.25$	A1
	$= (42 - '25') \times \frac{1}{21}$	$= ('17' - 0) \times \frac{1}{42} + (42 - '25') \times \frac{1}{42}$	$(10.5 - '6.25') \times \frac{1}{5.25}$	M1
	$= \frac{17}{21}$ oe			A1
				(4)
Notes				Total 9
(i)(a)	M1	For setting up a correct equation for the probability or the variance		
	M1	For setting up a correct equation for the probability and the variance		
	A1	For $a = 12$ and $b = 72$ (correct answers score 3 out of 3)		
(b)	M1	For an unsimplified equation ft their a and their b		
	A1	Cao		
(ii)	M1	For $\frac{L}{4} - \left(\frac{42-L}{4}\right) > 2$ or $\left(\frac{42-L}{4}\right) - \frac{L}{4} > 2$ or $S - (10.5-S) > 2$ may be seen in a probability statement allow any letter for L or S may be implied by $L > 25$ or $L < 17$ or $S > 6.25$		
	A1	$L > 25$ or $L < 17$ or $S > 6.25$ may be seen in a probability statement or implied by 2 nd M1		
	M1	For use of $(42 - '25') \times \frac{1}{21}$ or $('17' - 0) \times \frac{1}{42} + (42 - '25') \times \frac{1}{42}$ or $(10.5 - '6.25') \times \frac{1}{5.25}$		
	A1	Allow awrt 0.81		

Question	Scheme	Marks
3. (a)	$\frac{19}{24}$	B1
(b)	$P(R > 3.5) = \frac{-3.5 - (-5)}{19 - (-5)} + \frac{19 - 3.5}{19 - (-5)} = \frac{17}{24}$	M1, A1
(c)		M1 A1
(d)(i)	$P(R_1 > 10) = \frac{19 - 10}{19 - (-5)} \left[= \frac{9}{24} = 0.375 \right]$	M1
	$[P(R > 10)]^3 = \left(\frac{9}{24} \right)^3 = \frac{27}{512}$	M1 A1
(ii)	$1 - [P(R < 10)]^3 = \frac{387}{512}$	M1 A1
	Notes	[10 marks]
(a)	B1 allow awrt 0.792	
(b)	M1 sum of two regions from uniform distribution or $1 - \frac{3.5 - (-3.5)}{19 - (-5)} \left[= 1 - \frac{7}{24} \right]$ oe You may fit their denominator from (a) A1 allow awrt 0.708	
	SC M1A0 for $P(-3.5 < R < 3.5) = \frac{7}{24}$ (awrt 0.292) or for finding $P(R > 3.5) = \frac{31}{48}$ (awrt 0.646) and $P(R < -3.5) = \frac{1}{16}$ (0.0625)	
(c)	M1 straight line with increasing gradient. Allow a horizontal line to the right of 19 and/or a horizontal line to the left of -5 A1 starting at (-5, 0) and finishing at (19, 1) Need to be clear labels for -5, 19 and 1. 0 may be labelled or implied by the x-axis	
(d) (i)	1 st M1 for $P(R > 10)$ eg $1 - \frac{10 - (-5)}{19 - (-5)}$ no need to simplify. Implied by 0.375 or $\frac{27}{512}$ You may use their denominator from (a) 2 nd M1 ["their $P(R > 10)$ "] ³ They may use their denominator from (a) otherwise fit their $P(R > 10)$ only if it is clearly labelled. A1 allow awrt 0.0527	
(ii)	M1 Use of $1 - p^3$ $0 < p < 1$ (none are greater than 10cm from origin) or $3p^2(1 - p) + 3p(1 - p)^2 + (1 - p)$ $0 < p < 1$ working needs to be shown A1 allow awrt 0.756 SC M1A0 for finding the P (exactly 1 is > 10cm) = $\frac{225}{512} = (0.439...)$	

Question Number	Scheme		Marks
5(a)	$\frac{(a+6)^2}{12} = 27$		M1
	$a = \sqrt{27 \times 12} - 6 \Rightarrow 12^*$ or $a^2 + 12a - 288 = 0 \Rightarrow a = 12^*$		A1*
			(2)
(b)(i)	$\frac{12-b}{18} = \frac{3}{5}$ or $\frac{b+6}{18} = \frac{2}{5}$		M1
	$b = 1.2$		A1
			(2)
(ii)	$P(-6 < W < "0.6") = \frac{"0.6" + 6}{18}$		M1
	$= \frac{11}{30}$ or 0.3666....		A1ft
			(2)
(c)	Let C be the point where the wood is cut and x is the distance AC		
	$\frac{x}{2}$ and $\left(\frac{160-x}{2}\right)$	$L+W=80$ and $LW=975$	M1
	$\frac{x}{2} \times \left(\frac{160-x}{2}\right) = 975 \Rightarrow x = 30$ or 130	$L(80-L) = 975 \Rightarrow L = 15$ or 65	M1
	$P("30" < x < "130") = \frac{"130" - "30"}{160} \left[= \frac{5}{8} \right]$ oe	$P("15" < x < "65") = \frac{"65" - "15"}{80} \left[= \frac{5}{8} \right]$ oe	dM1
	$= \frac{5}{8}$ oe		A1
			(4)
Notes			Total 10
(a)	M1	for setting up the correct equation. Do not allow verification	
	A1*	for an un-simplified expression for a leading to $a = 12$ or for a correct $3TQ = 0$ leading to $a = 12$ Condone any letter for a	
(b)(i)	M1	for setting up the correct equation	
	A1	Cao oe	
(ii)	M1	for a correct method. Do not ISW	
	A1ft	ft their value for b , provided the answer is between 0 and 1	
(c)	M1	For both expressions seen. Allow any letters e.g. $\frac{y}{2}$ for $\left(\frac{160-x}{2}\right)$ May be implied by a correct equation for the area	
	M1	for a correct equation for area in terms of any letter. Condone an inequality	
	dM1	dep on previous method mark awarded. For a fully correct method ft their x values provided add to 160 or 80 Do not ISW	
	A1	Cao	

Question Number	Scheme		Marks
6(a)	$\frac{5-2}{b-a} = \frac{3}{16}$ oe or $1 - \left(\frac{2-a}{b-a} + \frac{b-5}{b-a} \right) = \frac{3}{16}$ oe	$\frac{5-a}{b-a} = \frac{3}{16}$ oe	M1
	$\frac{a+b}{2} = 6$ oe		M1
	$a = -2$ and $b = 14$	$a = 4.4$ and $b = 7.6$	A1
			(3)
(b)	$[cE(X) + 1 = 3 \Rightarrow] 6c + 1 = 3$		M1
	$c = \frac{1}{3}$		A1
			(2)
(c)	$\left[\text{Var}X = \frac{(b-a)^2}{12} = \right] \frac{64}{3}$ oe	$\left[\text{Var}X = \frac{(b-a)^2}{12} = \right] \frac{64}{75}$ oe	B1ft
			(1)
(d)	$E(X^2) = \left(\frac{64}{3} \right) + 6^2 = \frac{172}{3}$ or	$E(X^2) = \left(\frac{64}{75} \right) + 6^2 = \frac{2764}{75}$	M1A1
			(2)
(e)	$P\left(\frac{3}{2}X - b > a\right) \Rightarrow P(X > 8) = \frac{3}{8}$	$P\left(\frac{3}{2}X - b > a\right) \Rightarrow P(X > 8) = 0$	M1A1
			(2)
Notes			Total 10
(a)	M1	for using $P(2 < X < 5) = \frac{3}{16}$ or $P(a < X < 5) = \frac{3}{16}$ to form a correct equation in a and b May be implied by $b - a = 16$	
	M1	for using $E(X) = 6$ to form a correct equation in a and b May be implied by $a + b = 12$	
	A1	for $a = -2$ and $b = 14$ or $a = 4.4$ and $b = 7.6$	
(b)	M1	for use of $cE(X) + 1 = 3$ or fully correct integration seen e.g. $c \int_{-2}^{14} \frac{1}{16} x \, dx + 1 [= 3]$ May be implied by $c = \frac{1}{3}$	
	A1	Cao	
(c)	B1ft	ft their a and b Allow decimal answers correct to 3sf e.g 21.3	
(d)	M1	for use of $\text{Var}(X) + E(X)^2$ ft their $\text{Var}(X)$ or a fully correct integration seen e.g. $\int_{-2}^{14} \frac{1}{16} x^2 \, dx \left[= \frac{172}{3} \right]$ or $\int_{4.4}^{7.6} \frac{5}{16} x^2 \, dx \left[= \frac{2764}{75} \right]$ ft their a and b	
	A1	for $\frac{172}{3}$ oe or awrt 57.3 or $\frac{2764}{75}$ or awrt 36.9 oe NB Answer must match the method used	
(e)	M1	for $P(X > 8)$ or $P\left(X > \frac{2(a+b)}{3}\right)$ ft their a and b May be implied by a correct answer	
	A1	for $\frac{3}{8}$ oe or 0 Answer must match the method used	

Question Number	Scheme		Marks
2(i)(a)	$P(X > 14) = \frac{2}{5}$ oe		B1
			(1)
	(b) $a = 8 - 2(14 - 8) [= -4]$		M1
	$b = 14 + 2(14 - 8) [= 26]$		M1
	$P(6X > a + b) = \left(\frac{26 - \frac{26 - 4}{6}}{26 + 4} \right)$ oe		M1
	$= \frac{67}{90}$ oe	awrt 0.744	A1
			(4)
	(ii)(a) $S \sim U[0, 22.5]$ or $f(s) = \begin{cases} \frac{2}{45} & 0 \leq s \leq 22.5 \\ 0 & \text{otherwise} \end{cases}$		B1
			(1)
	(b) $P(S < 12) = \frac{12}{22.5}$		M1
(c)	$= \frac{8}{15}$	awrt 0.533	A1
			(2)
	(c) $P(T = 6) = {}^{20}C_6 \left(\frac{8}{15} \right)^6 \left(1 - \frac{8}{15} \right)^{14}$		M1M1
	$= 0.02072 \dots$	awrt 0.0207	A1
			(3)
			Total 11
Notes			
(i)(a)	B1	Allow 0.4	
(b)	M1	A correct method to find the value of a or $\frac{a+b}{2} = 11$ May be awarded in part(a)	
	M1	A correct method to find the value of b or a second correct equation ft their (a) eg $\frac{b-14}{b-a} = \frac{2}{5}$	
	M1	May be awarded in part(a)	
	A1	A correct probability expression using their value for a and their value for b	
(ii)(a)	B1	Correct answer	
(b)	M1	Correct distribution stated allow in words. Condone <	
	M1	Correct method ft their value of $(b - a)$ if positive. Condone 45 in the denominator for this mark	
	A1	Awrt 0.533	
(c)	M1	For $\left(\frac{8}{15} \right)^6 \left(1 - \frac{8}{15} \right)^{14}$	
	M1	Fully correct probability ft their 8/15	
	A1	awrt 0.0207	

Question Number	Scheme					Marks					
6(a)	$\left(2 \times \frac{a}{a+7} \times \frac{1}{4} \times \frac{3}{4}\right) + \left(\frac{a}{a+7} \times \frac{1}{4} \times \frac{1}{4}\right) = \frac{63}{256} \text{ or } \frac{a}{a+7} \times \left(1 - \left(\frac{3}{4}\right)^2\right) = \frac{63}{256} \text{ or}$ $\frac{a}{a+7} \times \left[\left(\frac{1}{4}\right)^2 + 2 \times \frac{1}{4} \times \frac{3}{4}\right] = \frac{63}{256}$					M1 M1					
	$\frac{a}{7+a} = \frac{63}{256} \div \frac{7}{16} \text{ or } \frac{a}{7+a} = \frac{9}{16} \quad \therefore a = 9 *$					A1*					
						(3)					
(b)	Range (R) 0, 5, 10 (and 15)					B1					
	Bag: $P(20) = \frac{9}{16}$ and $P(5) = \frac{5}{16}$ and $P(10) = \frac{2}{16}$					B1					
	$[P(R = 0) =] \frac{5}{16} \times \frac{1}{4} \times \frac{1}{4} + \frac{2}{16} \times \frac{3}{4} \times \frac{3}{4}$					M1 M1 M1					
	$[P(R = 5) =] 2 \times \frac{5}{16} \times \frac{1}{4} \times \frac{3}{4} + \frac{5}{16} \times \frac{3}{4} \times \frac{3}{4} + 2 \times \frac{2}{16} \times \frac{1}{4} \times \frac{3}{4} + \frac{2}{16} \times \frac{1}{4} \times \frac{1}{4}$										
	$[P(R = 10) =] \frac{9}{16} \times \frac{3}{4} \times \frac{3}{4}$										
	<table><tr><td>R</td><td>0</td><td>5</td><td>10</td><td>15</td></tr><tr><td>r</td><td>$\frac{23}{256}$</td><td>$\frac{89}{256}$</td><td>$\frac{81}{256}$</td><td>$\frac{63}{256}$</td></tr></table>	R	0	5	10	15	r	$\frac{23}{256}$	$\frac{89}{256}$	$\frac{81}{256}$	$\frac{63}{256}$
R	0	5	10	15							
r	$\frac{23}{256}$	$\frac{89}{256}$	$\frac{81}{256}$	$\frac{63}{256}$							
(6)											
Notes											
Total 9											
(a)	M1	For use of $\frac{a}{a+7}$ in an equation									
	M1	Setting up a correct equation to find the value of a									
	A1*	$a = 9$ with at least one further correct line of working									
(b)	B1	For the 3 ranges 0, 5 and 10 and no extra incorrect ones or all extras have probability of 0									
	B1	For the correct 3 probabilities written or used for the bag $\frac{2}{16}$ and/or $\frac{5}{16}$ may be implied by a correct answer for $P(R = 0)$ or $P(R = 5)$ and $\frac{9}{16}$ may be implied by a correct answer for $P(R = 10)$									
		NB p and q must be consistent for the next 3 method marks									
	M1	A correct method to find one probability for $P(R = 0)$ or $P(R = 5)$ or $P(R = 10)$ allow $p \times q \times q + r \times (1 - q) \times (1 - q)$ or $2 \times p \times q \times (1 - q) + p \times (1 - q) \times (1 - q) + 2 \times r \times q \times (1 - q) + r \times q \times q$ or $m \times (1 - p) \times (1 - p)$ where m, p, q and r are probabilities. (May be implied by $\frac{23}{256}$ or $\frac{89}{256}$ or $\frac{81}{256}$)									
	M1	A correct method to find two probabilities from $P(R = 0)$ or $P(R = 5)$ or $P(R = 10)$ allow $p \times q \times q + r \times (1 - q) \times (1 - q)$ or $2 \times p \times q \times (1 - q) + p \times (1 - q) \times (1 - q) + 2 \times r \times q \times (1 - q) + r \times q \times q$ or $m \times (1 - p) \times (1 - p)$ where m, p, q and r are probabilities. (May be implied by 2 from $\frac{23}{256}$ or $\frac{89}{256}$ or $\frac{81}{256}$)									
	M1	A correct method to find all 3 probability for $P(R = 0)$ and $P(R = 5)$ and $P(R = 10)$ allow $p \times q \times q + r \times (1 - q) \times (1 - q)$ or $2 \times p \times q \times (1 - q) + p \times (1 - q) \times (1 - q) + 2 \times r \times q \times (1 - q) + r \times q \times q$ or $m \times (1 - p) \times (1 - p)$ where m, p, q and r are probabilities. (May be implied by $\frac{23}{256}$ and $\frac{89}{256}$ and $\frac{81}{256}$) or these 3 probabilities that sum to $\frac{193}{256}$									

	A1	Correct ranges with correct associated probabilities attached. All extras must have an associated probability of 0 (Does not have to be seen in a table) NB Allow decimal answers correct to 3 decimal places $\frac{23}{256} = 0.090$ $\frac{89}{256} = 0.348$ $\frac{81}{256} = 0.316$ $\left[\frac{63}{256} = 0.246\right]$
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Question Number	Scheme	Marks
7(i)	$\frac{a+b}{2} = 9$ and $\frac{13-5}{b-a} = \frac{1}{5}$ or $a = -11$ and $b = 29$	M1
	$P\left(X > \frac{29-11}{3}\right) [= P(X > 6)]$ or $P\left(X > \frac{9 \times 2}{3}\right) [= P(X > 6)] = \frac{23}{40}$	M1A1
	(3)	
(ii)	$\frac{1}{12}(c-1)^2 = 0.48 \Rightarrow c = 3.4$	M1
	$E(Y) = \frac{1+3.4}{2}$	M1
	$E(Y^2) = 0.48 + \left(\frac{1+3.4}{2}\right)^2 = 5.32$	M1A1
	(4)	
(iii)	$W \sim U[0,20]$ $X \sim U[10,20]$ $Y \sim U[0,10]$	
	$W < 6$ or $W > 14$ or $X < 12$ or $Y > 8$ any letter, ignore distribution	M1
	$2 \times P(W < 6) = 2 \times \frac{(6-0)}{20}$ or $2 \times P(W > 14) = 2 \times \frac{(20-14)}{20}$ or	M1
	$P(W < 6) = \frac{6-0}{20}$ and $P(W > 14) = \frac{20-14}{20}$ or $P(X > 14) = \frac{20-14}{10}$ or $P(Y < 6) = \frac{6-0}{10}$	
	$P(8 < W < 12) = \frac{12-8}{20}$ or $P(X < 12) = \frac{12-10}{10}$ or $P(Y > 8) = \frac{10-8}{10}$	M1
	$P(\text{shortest side} < 6) = \frac{3}{10} + \frac{3}{10} + \frac{1}{5}$ or $\frac{1}{5} + \frac{3}{5} = \frac{4}{5}$	dM1A1
	(5)	
	Alternative 1	
	$6 < W < 8$ or $12 < W < 14$ any letter, ignore distribution	M1
	$P(6 < W < 8) = \frac{8-6}{20}$ or $P(12 < W < 14) = \frac{14-12}{20}$	M2 for $P(12 < X < 14) = \frac{14-12}{10}$ or $P(6 < Y < 8) = \frac{8-6}{10}$
	$P(6 < W < 8) = \frac{1}{10}$ and $P(12 < W < 14) = \frac{1}{10}$ or	
	$2 \times P(6 < W < 8) = 2 \times \frac{1}{10}$ or $2 \times P(12 < W < 14) = 2 \times \frac{1}{10}$	M1
	$P(\text{shortest side} < 6) = 1 - \frac{1}{10} - \frac{1}{10}$ or $1 - \frac{2}{10} = \frac{4}{5}$	dM1A1
	(5)	
	Alternative 2	
	$W > 10$ or $12 < W < 14$ or $6 < W < 8$ or $W < 10$ any letter, ignore distribution	M1
	$P(12 < W < 14) = \frac{14-12}{20}$ and $P(W > 10) = \frac{20-10}{20}$ or	M1
	$P(6 < W < 8) = \frac{8-6}{20}$ and $P(W < 10) = \frac{10-0}{20}$	
	$P(12 < W < 14 W > 10) = \frac{\frac{1}{10}}{\frac{1}{2}} = \frac{1}{5}$ or $P(6 < W < 8 W < 10) = \frac{\frac{1}{10}}{\frac{1}{2}} = \frac{1}{5}$	M1
	$P(\text{shortest side} < 6) = 1 - \frac{1}{5} = \frac{4}{5}$	dM1A1
	(5)	
	NB Any answer of $\frac{4}{5}$ scores 5/5 provided it has not come from incorrect working	
	Total 12	

Notes		
NB Allow any letter throughout the question		
(i)	M1	For setting up 2 correct equations May be implied correct answers for a and b
	M1	Realising the need to find $P(X > 6)$ or allow use of "their a " and "their b " or their " $\frac{a+b}{2} = 9$ "
	A1	23/40 oe or 0.575
(ii)	M1	Correct equation to find c with $c = \dots$
	M1	Correct method for finding $E(Y)$ using "their c "
	M1	Correct method for finding $E(Y^2)$ using "their $E(Y)^2$ "
	A1	For 5.32 (Allow $\frac{133}{25}$)
(iii)	M1	For identifying a correct region required to answer the question. Allow any letter and ignore the distribution associated with the letter. May be implied by $W < 6$ or $W > 14$ or $X < 12$ or $Y > 8$
	M1	For a correct method to find a required probability. Allow any letter but the probability must be associated to the correct distribution. e.g. $2 \times P(W < 6) = 2 \times \frac{3}{10}$ or $2 \times P(W > 14) = 2 \times \frac{3}{10}$ or $P(W < 6) = \frac{3}{10}$ and $P(W > 14) = \frac{3}{10}$ or $P(X > 14) = \frac{3}{5}$ or $P(Y < 6) = \frac{3}{5}$
	M1	For a correct method to find a second required probability. Allow any letter but the probability must be associated to the correct distribution. e.g. $P(8 < W < 12) = \frac{1}{5}$ or $P(X < 12) = \frac{1}{5}$ or $P(Y > 8) = \frac{1}{5}$
	dM1	Dependent on previous 3 M marks. For $P(W < 6) + P(W > 14) + P(8 < W < 12)$ or $P(X > 14) + P(X < 12)$ or $P(Y < 6) + P(Y > 8)$ ft their probabilities
	A1	cao
Alternative 1		
(iii)	M1	For identifying a correct region required to answer the question. Allow any letter and ignore the distribution associated with the letter. May be implied by $6 < W < 8$ or $12 < W < 14$
	M1	For a correct method to find a required probability. Allow any letter but the probability must be associated to the correct distribution. e.g. $P(6 < W < 8) = \frac{1}{10}$ or $P(12 < W < 14) = \frac{1}{10}$
	M1	For a correct method to find a second required probability. Allow any letter but the probability must be associated to the correct distribution. e.g. $P(6 < W < 8) = \frac{1}{10}$ and $P(12 < W < 14) = \frac{1}{10}$ or $2 \times P(6 < W < 8) = 2 \times \frac{1}{10}$ or $2 \times P(12 < W < 14) = 2 \times \frac{1}{10}$
	dM1	Dependent on previous 3 M marks. For $1 - \frac{1}{10} - \frac{1}{10}$ or $1 - \frac{2}{10}$
	A1	cao
Alternative 2		
	M1	For identifying a correct region required to answer the question. Allow any letter and ignore the distribution associated with the letter. May be implied by $W > 10$ or $12 < W < 14$ or $W < 10$ or $6 < W < 8$
	M1	For a correct method to find both the required probabilities. Allow any letter but the probability must be associated to the correct distribution. e.g. $P(12 < W < 14) = \frac{1}{10}$ and $P(W > 10) = \frac{1}{2}$ or $P(6 < W < 8) = \frac{1}{10}$ and $P(W < 10) = \frac{1}{2}$
	M1	For correct use of conditional probability e.g. $\frac{\frac{1}{10}}{\frac{1}{2}}$
	dM1	Dependent on previous 3 M marks. For $1 - \frac{1}{5}$
	A1	cao

Question Number	Scheme	Marks
6. (a)	$P(17 < W < k) = P(W < k) - P(W < 17) = \frac{53}{60} - \left(1 - \frac{1}{5}\right) = \frac{1}{12}$	M1 A1 (2)
(b)(i)	$\frac{(b-a)^2}{12} = 75, \quad \frac{b-17}{b-a} = \frac{1}{5} \text{ or } \frac{17-a}{b-a} = \frac{4}{5}$ $\frac{(b-a)^2}{12} = 75 \rightarrow (b-a) = 30 \quad \frac{b-17}{30} = \frac{1}{5}$ $b = 23 \text{ and } a = -7$	B1, B1 M1 A1 (4)
(ii)	$P(W < k) = \frac{k - (" - 7")}{"23" - (" - 7")} = \frac{53}{60} \text{ or } P(17 < W < k) = \frac{k-17}{30} = \frac{1}{12} \text{ or } P(W > k) = \frac{"23" - k}{"23" - (" - 7")} = \frac{7}{60}$ $k = 19.5$	M1 A1 (2)
(c)	$P(-5 < W < 5) = \frac{5 - (-5)}{"23" - (" - 7")} = \frac{1}{3}$	M1A1ft (2)
(d)	$E(W^2) = \text{Var}(W) + E(W)^2 = 75 + \left(\frac{"23" + " - 7"}{2}\right)^2 = 139$	M1 A1 (2)
[Total 12]		
Notes		
(a)	M1 for writing or using $P(W < k) - P(W < 17)$ allow $<$ or $\leq$ Allow equivalent expressions e.g. $P(W > 17) - P(W > k) = \frac{1}{5} - \left(1 - \frac{53}{60}\right)$ A1 oe condone awrt 0.0833 condone $\frac{1}{12}$ coming from $\frac{13}{12} - 1$ or $\left -\frac{1}{12} \right $	
(b) (i)	1 st B1 correct equation for variance 2 nd B1 either correct probability equation Allow e.g. k in place of $(b - a)$ 1 st M1 eliminating $(b - a)$ which must appear in both equations. A1 both $b = 23$ and $a = -7$ correct answers imply all 4 marks	
(ii)	M1 probability expression using uniform distribution ft their values A1 $k = 19.5$ oe cao	
(c)	M1 for $10/(\text{their } b - \text{their } a)$ A1ft $\frac{1}{3}$ oe condone awrt 0.333 (Allow ft $\frac{10}{\text{their}(b-a)}$ as exact fraction or evaluated to 3sf or better provided $a < -5$ and $b > 5$)	
(d)	M1 use of $E(W^2) = \text{Var}(W) + (E(W))^2$ with values substituted for $\text{Var}(W)$ and $E(W)$ ft their values of a and b allow any rearrangement. Must have a correct (ft) expression or value for $E(W)$ Also allow $\int_{"-7"}^{"23"} \frac{1}{"23" - " - 7"} w^2 dw$ A1 139 cao	

Question Number	Scheme		Marks
5(a)	U[0, 3]		M1
	$\frac{3-1.8}{3} = 0.4$		A1
			(2)
(b)	$X^2 = W^2 + (3-W)^2$		M1
	$X^2 = W^2 + 9 + W^2 - 6W \Rightarrow X^2 = 2W^2 - 6W + 9$		A1
			(2)
(c)	$E(W) = 1.5$		B1
	$\text{Var}(W) = \frac{9}{12} = \frac{3}{4}$		B1
	$E(W^2) = \frac{3}{4} + 1.5^2$		M1
	$E(W^2) = 3$		A1
	So $E(X^2) = 2 \times 3 - 6 \times 1.5 + 9 = 6$		M1A1
			(6)
(d)	$P(X^2 > 5) = P(2W^2 - 6W + 4 > 0)$		M1
	$= P((2W - 2)(W - 2) > 0)$		M1
	$= P(W > 2) + P(W < 1)$		dM1
	$= \frac{2}{3}$ oe		A1
			(4)
			Total 14
Notes			
(a)	M1	Writing or using the correct distribution	Allow: $\frac{1.8}{3}$ for M1A0
	A1	0.4 oe	
(b)	M1	Using Pythagoras to find the length	Note: $X^2 = W^2 + (W - 3)^2$ scores M1A0
	A1	Brackets multiplied seen leading to $X^2 = 2W^2 - 6W + 9$ with no incorrect working	
(c)	B1	1.5	
	B1	$\text{Var}(W) = 0.75$	Using integration: $E(W^2) = \int_0^3 \frac{1}{3} w^2 dw$ (ignore limits)
	M1	Writing or using $E(W^2) = \text{Var}(W) + [E(W)]^2$	$\left[\frac{1}{9} w^3 \right]_0^3$ (correct integration with correct limits)
	A1	3	
	M1	Use of $E(X^2) = 2E(W^2) - 6E(W) + 9$ with their values.	
	A1	6 An answer of 6 from correct working implies all previous marks.	
(d)	M1	For realising they need to find the probability of $2W^2 - 6W + 4 > 0$ (condone =)	
	M1	Solving their 3-term quadratic ($W = 1$ and $W = 2$ implies 1 st two M marks)	
	dM1	(dep on 2 nd M1) Realising they need to add the 2 outer areas	
	A1	awrt 0.667	

Question Number	Scheme	Marks
3(a)	$\begin{cases} \frac{1}{6k} & -k \leq x \leq 5k \\ 0 & \text{otherwise} \end{cases}$	B1 B1
		(2)
(b)		B1 B1ft
		(2)
(c)	$E(X) = \frac{-k + 5k}{2} = 2k$	B1
		(1)
(d)	$F(X) = \int_{(-k)}^{(x)} \frac{1}{6k} (da)$	M1
	$= \left[\frac{a}{6k} \right]_{a=-k}^{a=x} \Rightarrow F(x) = \frac{x}{6k} + \frac{1}{6} \text{ oe}$	Alt: $F(x) = \frac{x}{6k} + c$ Use of $F(-k) = 0$ or $F(5k) = 1$ giving $c = \frac{1}{6}$ A1
	$\begin{cases} 0 & x < -k \\ \frac{x}{6k} + \frac{1}{6} & -k \leq x \leq 5k \\ 1 & x > 5k \end{cases}$	B1 A1
		(4)
(e)	$\text{Var}(X) = \frac{1}{12}(5k - (-k))^2 = 3k^2$	Alt: $E(X^2) = \int_{(-k)}^{(5k)} \frac{x^2}{6k} (dx)$ M1
	$E(Y) = E(X^2) = \text{Var}(X) + (E(X))^2 = 3k^2 + (2k)^2$	$= \frac{1}{6k} \left[\frac{x^3}{3} \right]_{-k}^{5k}$ dM1
	$= 7k^2$	$\frac{125k^3 + k^3}{18k} = 7k^2$ A1
		(3)
(f)	$(P(Y < 2k^2) = P(X^2 < 2k^2) =) P(-\sqrt{2}k < X < \sqrt{2}k)$	M1
	$= P(-k < X < \sqrt{2}k)$	M1
	$\left(= \frac{\sqrt{2}k - (-k)}{6k} \right) = \frac{\sqrt{2} + 1}{6} \text{ or exact equivalent}$	A1
		(3)
		Total 15

		Notes
(a)	B1	correct pdf. Condone $\frac{1}{5k+k}$ but not $\frac{1}{5k-k}$. Must be seen in (a).
	B1	all correct, allow use of < instead of $\leq$. B0B1 is not possible.
(b)	B1	correct horizontal line / rectangle drawn which must be both sides of the y-axis. Ignore the presence or absence of vertical lines at $-k$ and $5k$
	B1ft	labels correct, $-k$, $5k$ and " $\frac{1}{6k}$ " ft on their $f(x)$, provided $f(x)$ is a constant.
(c)	B1	cao (condone $2 \times k$)
(d)	M1	a correct integral expression for their pdf from (a). Ignore/condone missing limits. May be implied by their integrated expression. Alternatively, attempts the equation of the line between $(-k, 0)$ and $(5k, 1)$
	A1	$\frac{x}{6k} + \frac{1}{6}$ oe A correct expression for $-k \leq x \leq 5k$ e.g. $\frac{x+k}{6k}$ will imply M1A1
	B1	1 st and 3 rd lines of cdf correct, allow use of 'otherwise' for one of these lines
	A1	for correct 2nd line of cdf correct: $\frac{x}{6k} + \frac{1}{6}$ oe e.g. $\frac{x+k}{6k}$ and $-k \leq x \leq 5k$ (oe), allow use of < instead of $\leq$
(e)	M1	correct calculation to find $\text{Var}(X)$, does not need to be simplified. Alt correct integral for their pdf in (a) (not just the general expression). Condone missing limits.
	dM1	dep on previous M1 for a correct calculation to find $E(Y)$ using their part (c). Alt attempt integration (not wrt k) for their pdf in (a), which must be a constant i.e. $\frac{x^2}{6k} \rightarrow \dots x^3$, and correct limits shown or used
	A1	cao
(f)	M1	for an attempt to find the range of possible values for X (inside region) involving $\sqrt{2k}$ or $\sqrt{2k}^2$ or $\sqrt{2k}$. May be implied by further work. May attempt 1 – outside region. You do not need to see $P(\dots)$
	M1	$-k < X < \sqrt{2k}$ seen or implied. e.g. $F(\sqrt{2k})$, $P(X < \sqrt{2k})$ May attempt $1 - P(\sqrt{2k} < X < 5k)$ do not be concerned with strict or inclusive inequality signs used.
	A1	cao or exact equivalent e.g. $\frac{\sqrt{2}}{6} + \frac{1}{6}$ or $\frac{\sqrt{2k} + k}{6k}$ (note decimal answer awrt 0.402 is M1M1A0) isw after correct answer seen